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Thesis entitled -

"ULTRA-VIOLET RADIATION:

Its Possibilites and Uses, with Special Reference to its Application in the Work of a Modern Public Health Department."

by

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ULTRA-VIOLET RADIATION

Its Possibilities and Uses, with Special Reference to its Application in the work of a Modern Public Health Department.

I. Historical.

II. Physical, Chemical and Physiological Properties of Ultra-Violet Rays:

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3. Photo-chemical Effects.

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2. Maternity & Child Welfare Department:

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Toddlers - Anorexia, Whooping Cough.

3. School Medical Department:

Inadequate increase in growth and weight; pallid children; anaemic children; rheumatic children - nodes, growing pains, chorea, carditis.
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ULTRA-VIOLET RADIATION

I. - HISTORICAL

From the earliest periods of the world's history light must have played a dominant part in the production and evolution of the various types of life both in plants and animals.

It opens up a fascinating vista of speculation to compare the types of man and the types of vegetation in the world to-day in different regions of the earth's surface, with the amount of available ultra-violet radiation from the solar spectrum. Without stressing the point, it would seem that the hardier types of both plant and man are evolved where ultra-violet radiation is not necessarily so powerful as elsewhere, but where heat and moisture are curtailed.

It would appear that light has been found absolutely essential to life in evolution. No life can exist in utter darkness.

The beneficial effects of sunlight have been recognised from the earliest times when Hippocrates and Celsus recommended sun-baths. The evolution of modern ideas on radiation goes back to the time of Isaac Newton who, in 1666, discovered the spectrum of visible light. In 1777 Scheele found that Silver Chloride was darkened by invisible rays above the violet end of Newton's spectrum. In 1800 Sir William Herschal showed that the maximum heating effect in the spectrum was to be found

in the region below the red end. In 1840 Herschel proved that the spectrum did extend below this region and showed that the Fraunhofer lines also extended to this infra-red region. In 1803 Inglefield commented on Scheele's original observations and suggested that an extension might exist at the violet end of the spectrum similar to that in the infra-red. Ritter and Wollaston were, however, the first to actually demonstrate that photographic plates were readily darkened by radiations above the violet end of the visible spectrum.

In 1842 Becquerel photographed a long ultra-violet region which contained many Fraunhofer lines and he extended the spectrum to about 3,400 Ångström Units.

Light was used quite empirically in the treatment of disease till the time of Charcot, who, in 1859, showed that light rays produced an effect on the skin which was quite independent of their heating properties. Only comparatively recently has an idea of the action of light and the precise rays of the spectrum involved in its therapeutic effects been arrived at and elucidated.

In 1893 Professor Finsen of Copenhagen showed that it was possible to lessen the amount of scarring in Smallpox patients by the use of red curtains, red glass, etc. which excluded the actinic rays of the sun. He demonstrated that sunburn was a reaction of the skin to the actinic rays in sunlight and that these actinic rays belonged to the ultra-violet region of the spectrum; that they had very little penetrative power in the skin, and penetration of vascular tissue was very small indeed.

In 1894 his name became world-famous owing to his work on lupus.

Finsen, owing to climatic conditions, relied chiefly on carbon-arc lamps and was the originator of modern light therapy. Dr. Rollier, of Berne, realised the possibilities of light therapy and in 1903 started his first light clinic at the Swiss village of Leysin. Rollier confined himself at first to the use of the sun's rays, and his development of "helio-therapy" and his success in certain forms of tuberculosis are now known throughout the world.

Sir Henry Gauvain, at Hayling Island and Alton, has combined the work of Finsen and Rollier and utilises successfully both natural and artificial sources of light. He realised that atmospheric conditions in this climate were not comparable to those of a Swiss village some 4,700 feet above sea level. A Finsen Light Clinic was established at the London Hospital under Dr. Sequeira some 20 years ago, but light treatment was overshadowed by the discovery of Roentgen Rays about 1895 and never became widely used in this country.

Ultra-Violet Radiations have been suspected or known for nearly a century and a half, but it has remained for the Twentieth Century to usher in their practical application on a wide scale in the cure or alleviation of disease.

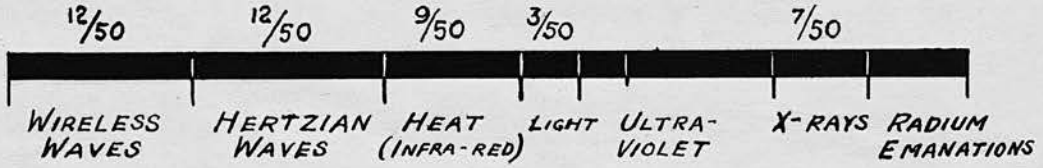
More recent workers in this country include Doctors Leonard Hill, Eidenow, Colebrook, Webster, Saleeby, Sir Henry Gauvain, and Mr. J. E. Barnard.

II. - PHYSICAL, CHEMICAL and PHYSIOLOGICAL PROPERTIES OF ULTRA-VIOLET RADIATIONS.

i. - Physics of Ultra-Violet Radiation.

Modern theories regard radiation as a propagation of energy in the form of waves. These waves have been shown to vary continuously in length from 20 - 30 thousand metres in the wireless region to the extremely short vibrations involved in radium emanations.

RADIANT ENERGY - DIAGRAMMATIC



A purely arbitary unit of measurement has been adopted for measuring and calculating the wave-mengths of visible and invisible light. This is known as the "Ångström Unit" which is one ten-millionth of a millemetre and is abbreviated as Å.U. The visible spectrum, as will be seen from the above diagram, covers a very short range of these waves, from 7,600 to 3,900 Å.U.

Photographic methods are conveniently used in investigating the ultra-violet regions and great technical difficulties have been overcome in this field of work.

Glass absorbs wave-lengths shorter than 3,300 Å.U.

and so lenses and prisms of fused quartz are used. With these, wave-lengths of 1,850 Å.U. have been reached. For regions with wave-lengths shorter than 1,850 Å.U. fluorite lenses, high vacua, and specially prepared photographic plates with very thin 'gelatin' are used. Schumann, by improving the photographic plate, investigated the far end of the ultra-violet spectrum which is now often referred to as the "Schumann Region".

There remained a band of short wave-lengths between 1,000 Å.U. and the long (soft) X-Rays.

Lyman[1] by dispensing with fluorite prisms and using a ruled grating got down to 1,030 Å.U. Millikan[2] got down to 150 Å.U.

This left a very short space between the shortest Ultra-Violet Rays and the longest X-Rays as measured by crystal spectography which ends about 13.3 Å.U. and using certain metals as electrodes Lyman and Millikan have apparently bridged this gap recently.

Source of Ultra-Violet Radiation.

The sun emits a continuous spectrum of great strength but wave-lengths shorter than 2,950 Å.U. are absorbed by the atmosphere. Magnesium flares, incandescent lamps, limelight, arcs between metals, spark gaps and vacuum tubes all emit ultra-violet radiation.

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1. Ref. LYMAN. Astrophysics Journal, 43, 89. 1916. "Science" 45, 87. 1917. "Extension of Schumann Region in Ultra-Violet." Ibid. 55, 161. 1922. "Spectroscopy of Extreme Ultra-Violet."

2. MILLIKAN. Astrophysics Journal, 52, 47. 1920. 286, 1920. 53, 150, 1921. "Extreme Ultra-Violet Region. 150 Å.U."

It must be noted that none of the sources of artificial light give a continuous spectrum like the sun, but show absorption bands at different regions. The influence of different wave-lengths in these spectra will be mentioned later.

Finsen used an arc between iron electrodes which is much stronger and gives a more even spectrum than carbon at the same wattage.

About 1901 Peter Cooper Hewit evolved the Mercury Vapour Arc Lamp in a quartz tube which stood the high temperature of the volatilised mercury and allowed 1000 times more ultra-violet rays to pass than glass lamps. More recently a Mercury Vapour Quartz Lamp working at slightly above atmospheric pressure has been made by the firm of Kelvin, Bottomley & Baird. This lamp is more stable than the vacuum lamps and does not fall off in power so rapidly.

At Harvard University a more recent Mercury Vapour Lamp has been constructed which has been worked at a pressure up to 5 atmospheres.

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ii. - Photo-Electrical Effects of Ultra-Violet Radiation.

A polished metal, such as zinc, if insulated, becomes positively charged when illuminated by Ultra-Violet Radiation.[1] If already negatively charged, it becomes discharged. The alkali metals seem to be particularly sensitive in this respect. Hertz (1888) showed that when ultra-violet radiations fall upon a spark gap the discharge takes place across it more readily. One is here tempted to suggest that this fact might be applied to the improvement of thermionic valves in wireless work by using quartz bulbs and radiating the valve while in action with a beam of ultra-violet light.

Abiotic phenomena occurring under the influence of Ultra-Violet Radiation.[2]

Marshall Ward threw the spectrum on an infected agar plate and showed that no growth occurred in the parts of the plate irradiated by the ultra-violet end of the spectrum, while those parts exposed to the visible and infra-red regions showed growth. About 1900 Finsen found that the abiotic action of rays became markedly evident as soon as he reached wave-lengths shorter than those contained in sunlight. The

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1. KRUEGER: Gen. Electric Review, Vol.XXV. No.5. P.318. "Ultra-Violet Light: Its Uses & Possibilites".
2. BOVIE: Bot.Gazette, 61, 1-29.1916. "Action of Schumann Rays on Living Organisms."
3. GALCOTTI: Am.Inst.Pasteur. 30, 49, 1916. "Action of Ultra-Violet Light on Bacteria."

(p. 8)

industrial application of this property of ultra-violet radiation was closely associated with the development of the means of production of the rays and advanced rapidly with the evolution of the quartz lamp. To-day ultra-violet radiation is used extensively for sterilizing water in swimming baths and has been used to sterilize milk. It is interesting to note that bacteria do not vary in their resistance to ultra-violet radiation as they do to chemical agents and to heat. For instance, spores which are often twenty times as resistant to other agents, are only 1·5 to 5 times as resistant to ultra-violet radiation than ordinary unprotected water bacteria.[3]

Mode of Action of Ultra-Violet Radiation on Living Cells.

Numerous theories abound as to the exact method by which ultra-violet radiation acts on living cells. It is generally conceded that the deadly action is due to some unknown quality inherent in the rays themselves and not to the action of some poison formed by them. Burge[4] showed that while liquifying bacteria are killed by ultra-violet radiation, the enzyme which produces the liquifaction is almost unimpaired. He also tried to demonstrate that the destructive action is due to coagulation of the bacterial protein. This coagulation was not always demonstrable.

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4. BURGE: Am. J. Physiol: 43.429.1917. "Action of Ultra-Violet Radiation in Killing Living Cells such as Bacteria."

If white of egg is exposed to ultra-violet radiation it coagulates. So does the protoplasm of the paramoecium and the vinegar eel (Anguillula Aceti). One can watch the death of the latter quite easily under the microscope. Movements become feeble in a few seconds and after about 30 seconds exposure to ultra-violet radiation the organism suddenly becomes still and is dead.

With white of egg the coagulation is not apparent till it is placed in a solution of calcium salts when the coagulated portion is rendered visible. It would seem that the protein of the egg white is changed in such a way by the rays that it can combine with the calcium salts and forms a coagulum.

Hill[1] sums up modern theory as follows:-

"The rays....knock off electrons from atoms and alter "the electrical charge of the ultra-microscopical "particles of the colloid protoplasm, which results in "an aggregation of these particles. There follows "chemical (molecular) change which is of such a nature "as to provoke....erythema, oedema, and lymphocytosis."

Hill and Eidenow have found an increase of the hydrogen ion concentration accompanying the killing of Infusoria with ultra-violet radiation.

Russ has shown that the most effective abiotic region of the spectrum is in the "far" region of the shorter

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[1] HILL, Leonard. B.M.J. Sept. 12.1925. P.471. "Influence of Light on Health."

waves ("Schumann Region") wave-lengths 1,800-2,200 A.U. although these waves have very little penetrative power and are stopped by 0.1 m.m. of human skin.[1]

Benoit[2] has reported remarkable success in the treatment of war wounds by ultra-violet radiation, the description of the changes in the wounds closely following those produced by Sir Almroth Wright's Hypertonic, Saline and Citrate dressings.

The concensus of opinion seems to be that ultra-violet radiation kills living cells and tissues by changing in some way the protoplasm of the cells so that certain salts can combine with the protein of the protoplasm to form an insoluable compound.

Harris[3] used solutions of amino-benzoic acid, tyrosin, leucine, cystine, etc. as screens for the organisms which protected them to a large extent, and concluded that the susceptibility of the protoplasm of organisms is due to the absorption of the toxic rays by amino-acid radicals of the protein. In other words that aromatic amino-acids are among the substances in bacterial protoplasm affected by the action of ultra-violet radiation. This work lacks confirmation.

A wide field for research remains in the action of

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1. BROWNING and RUSS: Proc.Roy.Soc. (4) (B) 90, 33, 1917. "Bactericidal Action of Ultra-Violet Rays.
2. BENOIT: Compt. Rendus. 165. 572. 1917. "Treatment of War Wounds."
3. HARRIS: Univ. California Pub. Pathology. 2. 245. 1919. "Action of Ultra-Violet Light on certain Bacteria in relation to Specific Absorption by Amino-acids."

ultra-violet radiations as a means of sterilizing bacterial suspensions for use as antigens. There is reason to believe that ultra-violet radiation of bacteria tends to favour a retention of antigenic properties while diminishing the toxicity of the organisms. It is well known that organisms, particularly those of the Gram negative group, such as B.Coli, etc., tend to produce rather irksome local and general reactions when killed by heat and used as a vaccine.

The writer is indebted to Dr. Lundie, of the Ministry of Pensions Laboratory, Birmingham, for help in the following experiment and for the use of laboratory animals. Unfortunately the laboratory was closed and so further work could not be carried out.

A week-old Alkaline Broth Culture of B. Dysenteriæ Shiga was taken and one ounce was exposed in a Petri Dish 4½ inches under an atmospheric type Mercury Vapour Quartz burner. Instrument readings were: Voltmeter, 250 V. Amperemeter, 2.6 Amps. Thermometer (4½ in. from burner) 40° C.

Cultures: Sub-cultures were made on Agar at 10, 20, and 40 minutes during the exposure and incubated at 37° C. The 40-minute sub-culture showed no growth. The 20-minute sub-culture showed delayed and scanty growth after 30 hours incubation. The 10-minute sub-culture showed some delay in growth.

2 c.c. of the broth after 40 minutes exposure proved non-toxic to a guinea-pig injected subcutaneously, whereas 2 c.c. of the non-irradiated broth produced peritonitis in another guinea-pig when injected in the same way.

The inhibitory power of ultra-violet radiation on a large mass of organisms in broth as outlined above, suggests the utility of this bactericide in preparing toxic bacteria, such as B. Dys. Shiga, for antigenic purposes. Anti-sera might be prepared from these toxic bacteria more readily by building up an immunity by injecting bacteria or their toxins which have been exposed to the rays for constantly diminishing periods of time.

It will be noted above that the Shiga toxin had lost its toxicity after irradiation.

Diphtheria toxin is stated to behave in a similar fashion. (Dr. Donald McCaskey, New York.)

Diphtheria Anti-toxin, on the other hand, is most resistant to radiation.

Eberson[1] states that prolonged shaking inactivates complement leaving amboceptor unchanged in a haemolytic serum. On the other hand, ultra-violet irradiation inactivates both complement and amboceptor,, while X-Rays do not affect either. Possibly this is due to the X-Rays penetrating the fluid easily, while

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1. EBERSON: J.Immunol. 5. 345. 1920. "Effect of Ultra-Violet Rays on Antigenic Properties."

the ultra-violet rays may be absorbed by the proteins. Agglutinins and anti-toxins seem to be the most resistant anti-bodies to ultra-violet radiation.

Effects of Ultra-Violet Radiation on Human Skin.

Müller of Tübingen has constructed a new "skin microscope" which magnifies by about 40 diameters. The skin is smeared with cedar-wood oil and the microscope lens applied. A good site for observing is above the lunule of the nail. The observer can see down to the sub-papillary plexus. Dilation of capillaries after ultra-violet irradiation was observed and this was found to persist for a week after exposure to the quartz lamp of 5 to 15 minutes. Pigment could also be studied. The skin microscope showed that when light is applied, the body sets about preparing a protective mantle of pigment as soon as it can after the light stimulus is applied.

This stimulus, if too sudden or too severe, causes the protective mechanism to resolve itself into an intense hyperaemia or as Nieukau[1] puts it, "The body hoists a red umbrella".

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1. NIEUKAU: Deut. Arch. f. Klin. Med. 301. July, 1920. (From Med. Ann. 1921. P.416.

Browning and Russ[1] performed some interesting experiments with sections of human skin taken from the abdominal wall, using layers 1/10th., ½, and 1½ m.m. thick. These were placed in front of the spectrograph slit, using a Simpson arc at 20 c.m. distance as the source of ultra-violet radiation. They showed clearly that the skin was very absorbent for wave-lengths between 2,100 - 2,960 Å.U., while from 2,960 - 3,800 Å.U. the waves were more penetrative, but not markedly so. In the first band of shorter wave-lengths a very small amount of ultra-violet radiation reached 1/10th. m.m. and the longer wave-lengths probably did not penetrate as deep as 1 m.m.

Russ has shown also that the shorter wave-lengths are highly bactericidal and have a sterilizing effect on skin surfaces exposed to them. Longer wave-lengths have not the same power.

Perhaps the most striking effect seen on skin is the erythema which results from exposure to ultra-violet radiation. After a well-ddfined latent period which varies from 4 to 8 or 10 hours, an erythema appears. (This latent period has not yet been satisfactorily explained.) The personal idiosyncracy of the patient causes this erythema to vary enormously. Other factors involved are the richness of the source of ultra-violet radiation, the time of exposure, the

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1. BROWNING & RUSS: Proc. Roy. Soc. London. Vol. XC.B. Oct. 1917.

the distance of the skin from the source of light, and the temperature of the room. Here again, the short wave-lengths, below about 3,200 Å.U., are alone responsible for the erythema. If screens of various sorts - 3% quinine solution or thick window-glass - are used, no erythema results,[1] because only the longer waves have passed. The erythema varies from the faintest flush to a markedly intense redness, which may last for 8 or 9 days, and is followed by definite and profuse peeling, accompanied by much irritation and sometimes oedema. If the dose is severe actual blisters may form. These however, heal up, leaving no scar. This erythema is apparently due toprofound changes in the superficial epithelial cells of the skin. It is accompanied by marked dilatation of the superficial capillaries which, according to Leonard Hill,[2] may dilate to double their size or even more - 4-5 fold. The capillary blood slows down and may even come to a standstill. Twenty-four hours after there is diapedesis of leucocytes from the deeper vessels. If the exudation is sufficient, continuity between the horny and granular layers of the epidermis is broken and a blister results.

Pigmentation. Following on the erythema we get desquamation, followed by pigmentation of the skin.

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1. HILL & EIDENOW: Pract. P.104. Aug. 1925. "The Practical Methods of Dosage of Ultra-Violet Rays."
2. HILL: "Sunshine and Open Air" (Edward Arnold & CO.) Page 93.

This varies enormously with individuals and also with the type of lamp used and the amount of erythema preceding it. In general, arc lamps produce a deeper pigmentation or bronzing (like "sunburn") than mercury vapour lamps. In the latter, the pigmentation is slight and more yellowish. After repeated exposures to the mercury vapour lamp the skin seems to lose its light sensitiveness and pigmentation remains slight.

Hill and Eidenow[1] state that pigmentation appears to be directly proportionate to the intensity of ultra-violet rays between 3,200 - 2,500 Å.U. The pigmentation of the skin is due to melanin which is deposited as granules round the nuclei of the epithelial and basal cells. Melanin apparently acts as a screen preventing excessive heating of the blood from the luminous and infra-red rays, and also screens the ultra-violet rays. Hill states that melanin powder extracted from the retina of the ox and mixed with water will protect the palm of the hand against the sun's rays focussed with a burning glass. He states that such a suspension absorbs all except the red-end of the spectrum. It is true that melanin will protect against the luminous and the ultra-violet rays, but it is difficult to reconcile this statement that protection exists against the infra-red rays, if it transmits red-rays. Given a pigmented skin, very much longer and greater doses

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[1] HILL & EIDENOW: Pract. Aug. 1925. P. 105. "The Practical Methods of Dosage of Ultra-Violet Rays."

of light may be given for longer periods and the erythema dose is considerably larger. Brunettes and dark-skinned subjects are, as a rule, much more tolerant to light than blondes.

Photo-dynamic Substances.

The whole question of light sensitiveness is one of absorbing interest and of great practical importance in the therapeutic application of these rays. Apparently no two persons are exactly alike in their sensitiveness to ultra-violet radiation. Even the hairs on the body respond differently to irradiation. The beard grows more rapidly during the day on which the operator irradiates his patients. Hairs on the forehead, on the other hand, are apparently not stimulated. The sun's rays can produce acute solar dermatitis, for which the actinic rays are solely responsible, as it occurs from the cold reflected rays in a snowfield. Certain substances described as "photo-dynamic substances" have the power of rendering individuals extremely sensitive to sunlight or ultra-violet radiation. Amongst these are eosin, methylene blue, fluorescin, haematoporphyrin, chlorophyll, and some of the heavy metals (gold, silver, iron, mercury, etc.) Hydroa Aestivale is a recurrent eruption affecting the parts of the skin exposed to sunlight, and is characterized by the presence of vesicles and papules and even blebs, and is most marked in the summer. In several cases J. H. M. McLeod claims to have discovered

haematoporphyrin in the urine and in the blood serum during an attack. McLeod[1] suggests that other obscure diseases, such as Pellagra and Xeroderma Pigmentosum are associated with some toxic substance which renders the skin super-sensitive to light. Betz injected into himself intravenously 0.2 grm. haematoporphyrin and detected it in the urine and blood serum shortly afterwards. He became and remained extremely sensitive to light for several months. This is a most important contribution to the subject of light sensitiveness. Eosin in 1% aqueous solution has been stated to be of use in the treatment of lupus patches, rendering them more sensitive to ultra-violet radiation, and enabling one to obtain stronger local reactions on the lupus patch. The writer's experience has not confirmed this. W. Duke[2] reports a case of remarkable sensitiveness to sunlight in a woman aged 43. This sensitiveness commenced to develop 4 years previous to her being seen by him. Wheals on the skin appeared in 5 minutes after being exposed to sunlight for 2½ minutes. He adds that this effect was <u>not</u> produced by heat, X-rays, nor by ultra-violet radiation from a quartz lamp. Neither the urine nor the blood serum showed any

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1. J.M.H.McLEOD: Pract. Jan. 1924. P.24. "Light - Its Action on the Skin and Therapeutic Value."
2. W.DUKE: J.Am.Med.Assoc. June, 1923. P.1835. (From Medical Annual, 1924, p.505.

haematoporphyrin nor any other photodynamic substance. Hydroa may exist without porphyrinuria, but Garrod and Mackey[1] point out that porphyrin may be present in the faeces and not in the urine. Where porphyrin is not detected, it must be assumed that some other photo-sensitizing agents are present. Porphyrinuria is stated to be a very rare condition. The pigment would appear to be an intermediate product between blood-pigment and bile-pigment, and is present in the ante-natal meconium.

Red Blood Cells and White Blood Cells.

The red blood cells act as a screen to ultra-violet radiation, the haemoglobin absorbing the rays and thus protecting the blood fluids from the destructive effect on complement and amboceptor as mentioned above. Under ultra-violet radiation red blood cells slightly increase in number and the haemoglobin content also increases after continued treatment. Generally speaking, one had found an increase in leucocytes after even one dose, about two to four thousand, reaching its height in about 4 to 5 hours after exposure. Differential counts show this increase to be mainly lymphcytic in type. All published results[2] agree that ultra-violet radiation stimulates a

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1. GARROD & MACKEY: Quart. J. of Med. July, 1922. P.319.

2. ARGYLL CAMPBELL & LEONARD HILL: Brit. J. Exp. Path. 267 (1924). "The Effect of Light on Leucocytes and Blood Vessels in the Mesentery of the Living Animal."

lymphocytosis in man and animals. Colebrook, Eidenow and Leonard Hill[1] showed that when the skin was mildly irritated with ultra-violet radiation, radiant heat, or mustard baths, there was a definite increase in the bactericidal power of the blood. Red blood cells are protected from ultra-violet radiation by the serum, on the other hand, if suspended in saline they are readily haemolysed by ultra-violet radiation.

Dr. Eidenow has shown more recently that exposure of defibrinated blood in vitra destroys its bactericidal properties. On the other hand, when this irradiated blood is re-introduced into the circulation an augmentation of the bactericidal power of the circulating blood is obtained. These workers attribute this augmentation of bactericidal power in blood to improved functions of the leucocytes.

If irradiation is too severe, the above investigators were able to demonstrate a deterioration of the blood no less striking than the improvement obtained with suitable doses. This observation has been borne out in the writer's experience clinically, and in several cases where slight over-doses of ultra-violet radiation have been given, slight but definite untoward results were forthcoming. This was observed chiefly in irradiation given to cure or abort a "cold".

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1. COLEBROOK, EIDENOW, & HILL: Brit. J. of Exp. Path. 5. 54. 1924. "The Effect of Radiation on the Bactericidal Power of the Blood."

In several cases the "cold" got rapidly and surprisingly worse and was accompanied by headache, torpor, and lassitude, with nervous irritability. On the other hand, suitable doses often succeeded in cutting short an acute coryza and preventing it conforming to the types prevalent at the time.

Action on Blood Platelets.

Dr. R. G. Bannerman,[1] working at Montana in Switzerland, reports to the Medical Research Council during the year 1924, that a hot sun bath which raises the general temperature, is followed by an increase in the number of blood platelets. This effect is also obtained after a hot bath and this would suggest that heat is the important factor. The blood platelets are found to be decreased in infections such as acute coryza, measles and influenza, and much increased in pulmonary tubercle.

Cramer and Drew[2] have found that blood plates are abnormally small in numbers where animals are kept in the dark from birth. Ultra-violet radiation will cause an increase in the plates in such animals. Platelets are found to be diminished in rickets and in animals starved of Vitamin A.

The relation of platelets to various infective conditions

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1. R. G. BANNERMAN: Lancet. Sept. 30. 1924. "Blood Plate Counts in Pulmonary Tuberculosis."
Brit. J. of Exp. Path. 5, 16. 1924. "Variations in the Number of Blood Plates associated with a Common Cold."

2. CRAMER & DREW: Brit. J. of Path. Oct. 1923.

is obscure, but ultra-violet radiation is know to increase their number.

It has been stated that an overdose of ultra-violet radiation will reduce the platelets. Possibly this partly explains the bad effects of an overdose in acute coryza, where the blood platelets, already low, may be further depressed.

Absorption of Ultra-Violet Radiation by Blood Sera.

Serum contains about 8% Proteins, including albumin, pseudo-globulin and eu-globulin.

Judd Lewis[1] investigated the contribution made by each protein constituent of serum to the ultra-violet absorption spectrum curve of blood serum. He used a new sector spectrophotometer of improved design, and after separating the three proteins, examined each in a 2 c.m. observation tube with quartz ends, using 0.08% solution in distilled H_2O for the albumin, and 0.04% for the pseudo-globulin and eu-globulin. Absorption curves were plotted with extinction coefficients as ordinates and wave-lengths as abscissae. He showed that the absorption-curve of pseudo-globulin is constant and is the same for horse and man. The absorption-curve for en-globulin differs considerably from that of pseudo-globulin in extinction coefficients, but not in its general form. As regards albumin,

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1. S. JUDD LEWIS: Proc. Roy. Soc. B. Vol.93. 1922.

the absorption curves for horse and human varieties are shown to be the same except for a constant ratio in their magnitudes. He suggests that this may be due to the physical, and possibly chemical association of an aggregate possessing little or no selective absorptive power, with the principal or absorbing aggregate.

Comparisons between the absorption of the proteins of human serum and horse serum reveal absorption bands somewhat greater in dimensions for the latter than for the former. It is obvious that the above facts explain the protection of red blood cells by the blood serum against haemolysis by Ultra-violet radiation.

Effects of Ultra-Violet Radiation on the Calcium and Phosphorus Content of Serum.

In normal children the inorganic phosphorus in the blood serum is about 5 millegrammes per cent, while the calcium content is somewhere near 10 millegrammes per cent.

It has been quite definitely established by numerous workers[1,2,3] that rickets is associated with a diminsihed calcium and inorganic phosphate content. In rachitic children it is usually the inorganic phosphate which is low and it may fall as low as

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1. B. KRAMER & F. H. BOONE: Proc. Soc. Exp. Biol. & Med. 1922, 20. 87.
2. GRACE ANDERSON: Brit. J. Child. Dis. 21. 33 & 107. "The Calcium and Phosphorus Content of the Blood in Normal and Rachitic Children."
3. M. A. LUNDLAGEN: Proc. Soc. Exp. Biol. & Med. XIX. 1922. P. 380.

1 m.g. per cent.

Hess,[1] working on the blood of New York children, claims that there is a seasonal variation of inorganic blood phosphates, which falls during the winter up to March, and rises again in the spring to a maximum in the late summer. Hess[2] has demonstrated a rise in the inorganic blood phosphate of rachitic children following ultra-violet radiation treatment. This has been amply supported by other observers,[3,4] and occurs within two weeks of beginning treatment. The calcium content of the serum is also notably increased by ultra-violet radiation, particularly in the case of infantile tetany treated with light. In rickets the blood calcium is often reduced. In tetany it is always reduced and may fall as low as 3.5 m.g. per cent. Calcium therapy helps symptoms, but the calcium content in serum does not quite attain normal. With ultra-violet radiation treatment however, the blood calcium can be raised to practically normal - and this also within an average period of two weeks, as in the case of phosphorus.[6] McCollom[5] states it is not a diminution of phosphates which matters in rickets but a disturbance of the normal ratio between calcium and phosphorus. This is the more modern view.

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1. HESS & LUNDLAGEN: Proc. Soc. Exp. Biol. & Med. XIX.1922.p.380.
2. HESS & GUTMAN: J.Am.Med.Assoc. June, 29. 1922.
3. WYMAN & WEYMULLER: Boston Children's Hospital. at 75th. Annual Session Am. Med. Assoc., Sect. Dis. Children. Chicago - June, 1924.
4. KRAMER, CASPARIS & HOWLAND: Am. J. Dis. Ch. Chicago. 20-26, XXIV. 1922. "Ultra-Violet Radiation in Rickets: Effect on Calcium and Inorganic Phosphorus in the Serum."
5. McCOLLOM: Abt. Pediatrics. Vol.II. p.935.
6. HOAG, L.A. Am. J. Dis. Ch. 36, 186. 1923. "Treatment of Infantile Tetany with Ultra-Violet Radiation."

iii.-Photo-Chemical Effects of Ultra-Violet Radiation.

Ultra-Violet Radiation is very active chemically and over 100 years ago Theodor von Grotthus formulated the law of photo-chemical absorption, viz., "that only the rays absorbed are effective in producing chemical change."

Professor E. C. C. Baly,[1] speaking on the conception of "high energy" chemistry as opposed to "low energy" chemistry - the everyday reaction of inorganic chemistry - conceives three separate stages in every chemical reaction:-

1. The activation of the reactant molecules by the supply of a definite and specific increment of energy;
2. The reaction proper, whereby new molecules are produced in an activated condition;
3. The loss of energy by the resultant molecules whereby they settle down into their normal state.

He instances the action of ultra-violet radiation on carbonic acid as an example of "high energy" chemistry and states that the first stage is the conversion of the carbonic acid into formaldehyde -

$$H_2CO_3 = HCOH + O_2$$

This is transient, and when means are taken to remove

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1. E.C.C.BALY: Jour. of State Med. Sect. V. Aug. 1925. P.368. Pres. address on "High Energy Chemistry and Vitamins."

the oxygen the reaction proceeds. The formaldehyde polymerises and gives hexose sugars.

$$6H_2CO_3 = 6HCOH = C_6H_{12}O_6 + 6O_2$$

This is probably the first stage in photo-synthetic processes in living plants. In plants the oxygen is removed by the four pigments, the two chlorophylls, carotin and xanthophyll. The two former are credited with enabling the reaction to take place with visible light and the relatively small amounts of ultra-violet rays available in sunlight.

Baly insists on the great importance of the hydrogen ion concentration in these reactions, suggesting that this factor determines the different types of alkaloids produced by the action of photo-synthesis in plants.

Thus we have learned that light can change a substance to a state of higher energy content, and also maintain it in that state, and also one can observe the emission of energy when the reverse change takes place. During the reverse change the energy is sometimes emitted as visible light (phosphorescence or fluorescence), or by the long wave radiation in the infra-red which is invisible (heat).

Ultra-violet radiation readily affects the decomposition of alcohols, aldehydes, organic acids, and ketones, and gives polymerizing effects in the case of acetylene, ethylene, cyanogen and oxygen, causing a diminution in volume. The activity of photolytic

decomposition decreases markedly as the weights of the compounds increase.

Ultra-violet radiation has a stronger action in producing phosphorescence and fluorescence than visible light. When the luminous visible rays of a quartz mercury vapour lamp are cut out by means of a dark glass containing nickel, the ultra-violet rays are demonstrated to be invisible in a dark room. A piece of uranium glass introduced into the invisible beam is seen to fluoresce beautifully and the amount of penetration of the ultra-violet rays into the block of uranium glass can be seen and measured. If this invisible beam is directed on the skin a generalised violet fluorescence is seen, especially over the teeth and nails. On the face numerous small non-fluorescent spots are observed and also small brightly-fluorescent spots. Very beautiful effects are produced on a wide range of substances, such as salicylic acid, oils and starches. Dead teeth absorb the rays almost completely and appear quite black.

III - ULTRA-VIOLET RADIATION IN THE TREATMENT OF DISEASE.

(a) Choice of Source of Ultra-Violet Rays.

It should be realised that there is a quite definite limit to the available wave-lengths from the sun owing to the absorption of all rays shorter than about 2,950 Å.U. Apart from the scanty amount of sunlight obtained in these islands, the intensity of sun-radiation received is subject to so many variations owing to cloud, smoke and temperature, that more and more reliance has been placed in recent years on artificially produced ultra-violet rays. Moreover, sun radiation has a very large proportion of heat rays which in some cases may be harmful. With an artificial source of ultra-violet radiation the factors are reasonably constant and can be reproduced at will by adjustment of voltage, amperage, temperature of room, time and distance of the irradiated subject from the lamp. The rays at the red end of the visible light spectrum are 7,500 Å.U. - those at the violet end are 3,900 Å.U. At this point commences the ultra-violet rays. For practical purposes we are interested in those wave-lengths down to 1,850 Å.U. The air absorbs waves shorter than these and so shorter waves cannot be used for therapeutic purposes. For purposes of treatment the chief region lies between 1,850 Å.U. and 3,900 Å.U.

Sun lamps emit a number of rays of different wave-lengths giving rise to different effects - heat rays, light or luminous rays, and ultra-violet rays.

i. Heat Rays - warm the skin and produce sweating. If severe, they produce a burn, but ample warning of this is given by the patient's sensory nerves. They penetrate the tissues to a considerable distance - 10 to 14 centimetres.

ii. Luminous Rays - have many photo-chemical properties. They can penetrate the skin to the deeper layers and are said to raise the temperature of these deeper layers by 3° or 4° Centigrade, and thus may increase lymph circulation. They have practically no direct bactericidal action and do not produce erythema or sunburn.

iii. Ultra-violet Rays - have definite and marked photo-chemical and photo-electrical properties. They are invisible to the eye and yet produce marked erythema and sunburn after a definite latent period of 6 or 8 hours. No warning of this result is given by the patient's sensory nerves during the period of irradiation. They are markedly bactericidal to surface organisms but penetrate the skin to a very slight extent - 1/10th. m.m.

The type of lamp here discussed will, in the first place, be one intended for general treatment as opposed to local treatment of restricted areas and small cavities. We have the choice between the ordinary arc lamp and the

quartz mercury vapour lamp. From the point of view of a Health Officer dealing with lay committees and concerned with expense, it is useful to compare the two.

The Ordinary Arc Lamp.

Intensity of radiation seems to depend on the length of the arc. The quality of the radiation depends on the type of electrode used. Tungsten and metal-cored carbons emit shorter ultra-violet radiations than plain carbons. ("Far" ultra-violet region). Iron electrodes give a spectrum which approximates to a continuous arc like that of the sun. The carbon arc emits a very intense radiation in the "near" ultra-violet region just beyond the violet end of the spectrum, which has the greatest skin penetrative powers, but is not so rich in the shorter and more bactericidal ultra-violet radiations obtained from the Tungsten and mercury vapour arcs.
The arc lamp emits considerable heat and in the case of the Tungsten electrode arc, most irritating fumes. The electrodes have to be adjusted as they burn, either by hand or by some sort of mechanism. They burn away at the rate proportional to the wattage used and so have to be renewed. Some of these lamps splutter and are apt to burn the patient. The large arc lamps are costly in initial expense and upkeep, and are difficult to adjust to constant intensity. They take from 50 to 60 amperes per lamp. Patients have to be exposed for long periods to these lamps as they cannot sit too

near them.

The Quartz Mercury Vapour Lamp.

This lamp is very rich in ultra-violet rays, especially at the "vital" region of the spectrum, 2,400 to 3,100 Å.U., but is not so powerful in heat rays. Its spectrum shows a very marked selective luminous ray (green and yellow).

There are two types on the market - one the vacuum type, and the other a type of lamp working at atmospheric or a little above atmospheric pressure. Some of the vacuum types are very inefficient and all vacuum types tend to grow weaker as they are used. After about 1,000 hours the lamp has to be cleaned and re-exhausted. On the other hand, the atmospheric lamp is rather more powerful, having an intensity of about 3 to 2 compared with the vacuum type of similar size. It is automatic in action and does not require renovation under 2,000 hours.

After removing the mercury with a vacuum pump, cleaning the reservoirs out with nitric acid, and replacing the mercury, the lamp is ready for use again. This lamp starts up on 4 to 5 amperes and in a few minutes settles down to burn at 2.6 amperes. The lamp is silent, does not give off much heat (40° C. at 4½ inches) and is exceedingly efficient and cheap to run - under 2d. per hour (230 Volt type).

If used unscreened, six patients may sit round it comfortably. Relatively short exposures are required

to obtain apparently similar effects to those produced by the bigger carbon or similar type arc lamps.

Turning now to the question of local treatment, surface lesions involving relatively small areas ~~may~~ may be treated by the above lamps and erythemata from mild redness to blistering burns may be obtained with a quartz lens mounted in a holder of wood and pressed down on the lesion, thus securing local blanching of the skin and obtaining greater penetration of the rays. For the treatment of mucous membranes and cavities of the body however, we are restricted at present to the use of the quartz mercury vapour lamp of the vacuum type, mounted in a metal globe and cooled by a system of water circulation. A quartz window in the globe emits through a system of quartz lenses a small beam of intense light of short focal length. Such lamps are rather fragile and liable to small troubles and inconveniences, and are costly. In the near future an air-cooled burner of atmospheric type mounted in a special shield will be evolved for local work. This will be relatively cheap in initial cost and may be used for the dual purpose of general irradiation (with shield removed) and for local applications in restricted areas.

(b) Dosage.

Definite guidance as to the correct dosage of ultra-violet radiation is in a much less developed stage than in the case of the X-rays. The most easily observed clinical effect of the ultra-violet rays is the production of erythema and in this respect the dosage is bounded by fairly narrow limits. Lamps, even of the same size and make, vary amongst themselves, and each lamp tends to lessen its ultra-violet ray output the longer it is used. Patients, too, vary enormously in their sensitiveness to ultra-violet radiation. The administration of either excessive or insufficient doses is very apt to result.

In treatment the aim may be, broadly speaking -

(1) To improve the state of the patient by general irradiation.

(2) To attack local lesions.

In the former, as a rule, the best and quickest results are obtained by the production of a very mild erythema which lasts a few hours and leaves no desquamation; while in the latter, one tries to obtain a more marked counter-irritant effect ranging from a deep erythema to a blistering burn.

For clinical purposes it is convenient to classify erythema reactions into four groups:-

Reaction 1st°. Simple mild reddening of the skin.

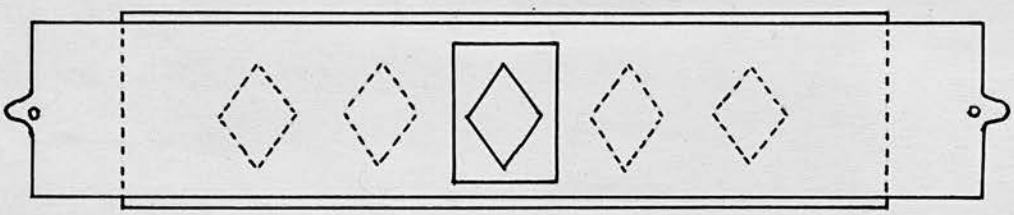
Reaction 2nd°. Reddening of the skin followed by slight itching and powdering of the skin.

Reaction 3rd°. Marked reddening of the skin, discomfort some oedema, followed by profuse peeling.

Reaction 4th°. Profound irritation of the skin, with formation of blisters and oedema.

Actinometers.

Actinometers do not help very much in dosage, but they are of great assistance in checking the ultra-violet ray output of a lamp or lamps. In acutal practice, the writer's plan is to secure an oblong piece of thick cardboard and cut five small windows in it. This is laid on the patient's abdomen and and another slip of cardboard superimposed.



Each aperture is uncovered to the rays of the lamp at 1 foot distance for 1 minute, or if one suspects that the patient is tolerant, for 2 minutes. Thus in the latter case we have 5 small areas exposed, 10 min. 8 min. 6 min. 4 min. and 2 min. at 1 foot. Next day these can be inspected.

A suitable initial dose for general treatment is ¾ to 1 minimum erythema dose. The rule is that the effects of the lamp vary inversely as the square of the distance of the object from the lamp. With test areas, as above, there is very little difficulty

indeciding upon the time and distance depending on the type of treatment desired. If many patients are treated and time forbids the use of the above method, as a general rule it is usually safe to begin with a light bath of 3 minutes at 3 feet with the average quartz lamp running from 220 volts circuit.

In some cases improved results may be obtained by general mild irradiation and at the same sitting production of a definite erythema over a localised area.

Eidenow and Hill[1] state that at least 15 sq. c.m. of skin per kilo of body weight is the minimum of skin area which must be irradiated to produce an increase in the bactericidal power of the blood.

These authorities state that the minimum erythema dose in a normal white skin corresponds to twice the time required for killing a standard culture of infusoria in a standard quartz cell at a temperature of 20° C. They express the power of a lamp in Infusoria-Killing Units. (I.K.Units). Various actinometers have been suggested for comparing the ultraviolet intensities of various lamps. Hill suggested the use of a solution of 30% pure acetone coloured with methylene blue. This is bleached by ultraviolet radiations and is compared with a scale of coloured tubes biologically standardised. One on the

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[1] EIDENOW & HILL: Pract. Aug. 1925. P.106.

scale equals twice to four times the dose required to produce an erythema of white skin.

A great deal of stress has been laid by numerous writers on the importance of the production of erythema in light therapy, and in the development of pigmentation. The author believes that too much attention has been paid to these statements. In actual practice it has been found that many patients, particularly young children and babies suffering from malnutrition, debility or rickets, showed rapid and complete improvement without evincing the slightest erythema.

Another common assertion is that the degree of pigmentation obtained is an indication of the resistance of the body to disease. This is entirely erroneous. Observation of any group of patients treated with light will show that some of them with similar colouring and complexions will pigment more than others quite irrespective of the condition of their general health.

Pigmentation is much more marked with carbon-arcs and these remarks apply to patients treated with quartz lamps, where beneficial results are obtained with slight pigmentation, or, more commonly, with no pigmentation at all.

Pigment is protective to the skin, and in practice it is found more useful to retain the light sensitiveness of the skin, rather than dull it by the establishment of marked pigmentation. Indeed, an excessive exposure resulting in a marked erythema confers an immunity on

the skin treated and it is often difficult to repeat the result without great increase in dose. A complete rest of the immune area of skin, however, results in a restoration of sensitiveness.

Rollier holds that pigment acts as a transformer of light energy in the tissues, which liberates more beneficial radiation. Against this view is the well-known fact that in New York City, negro babies more often develop rickets than white babies.

Apart from the above results of exposure and probably a much safer guide to proper dosage, is the subjective state of the patient. Excessive dosage, apart altogether from any question of whether erythema was produced or not, shows itself by a feeling of weakness, malaise, irritability, sleeplessness, or loss of appetite. On the other hand, suitable doses in the same patient are followed by a definite feeling of "bien être" increased vigour and cheerfulness, an increased capacity for work and play, and improved appetite and energy.

(c) Daagers.

Epithelioma. In a letter to the British Medical Journal, dated March 28th. 1925. P.631, Sir Lenthal Cheatle and Dr. Heald uttered a note of warning regarding the application of ultra-violet radiation treatment and hinted at the possibility of remote effects, such as the production of epithelioma. He stated that with Dr. Arthur Whitfield he had examined sections of "bronzed" skin after ultra-violet radiation treatment and found mitosis occurring in epithelial cells of the basal layers of the skin, from which he seemed to conclude that there might be a risk of inducing epithelioma. This letter was followed by a statement from Dr. Rollier[1] of Leysin, who stated that as the irradiations produced an increase of all the vital phenomena of the skin, it was not extraordinary that the generative layers of the skin should present more numerous mitoses. He had never seen cutaneous epitheliomata occur in any case of lupus treated only by heliotherapy.

Dr. Sequeira, of the London Hospital, has often uttered warnings of the dangers of epithelioma being produced in scaly lupus through prolonged treatment by X-rays, but he stated that in 23 years he had never seen harm to the skin of this nature after use of the Finsen light.

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1. B.M.J. May, 9. 25. P. 903.

Dr. Axel Reyn states that amongst thousands of patients who have received photo-therapeutic treatment for lupus at the Finsen Institute, no case of lupous carcinoma has been met with due to the treatment. On the other hand, he claims that the percentage of lupous carcinoma in their records is the lowest existing. If the ultra-violet radiations were provocative this would not be the case.

Dermatitis. Drs. McCormac and McCrea[1] drew attention to the dangers of unqualified and untrained persons using powerful remedial agents, and quoted the case of an old man who went to sleep under a mercury vapour lamp while treating himself, with the result that he developed a most severe dermatitis. An interesting point was that the dermatitis appeared both back and front. One can only surmise that theold man turned over in his sleep, for in the course of one's experience, in no case has a marked erythema on the side of the body exposed been accompanied by an erythema on the unexposed areas.

Accidents of the above type are rare, but due care must be exercised with individual patients. One has seen a very few light-sensitive patients who developed a marked third degree erythema and who had to lie in bed for a few days. These patients felt depressed, languid and out-of-sorts, the skin was very tender

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[1] B.M.J. April. 11.25. P.693.

and oedematous and there was profuse and repeated desquamation; but recovery was complete. Even in cases where a local blistering burn was produced, complete healing without scarring always resulted.

Discomfort in such cases may be reduced by the application of Hamamelis compress, or the application of some simple ointment. Such untoward results are most likely to occur in patients who have absented themselves and then returned and slipped into the treatment room continuing at the old exposure or getting an increase of dose.

Malaise. Every now and then one meets with a type of patient who complains of drowsiness almost immediately after a light bath, with a few hours later a feeling of loss of energy, appetite, slight headache, irritability, and perhaps sleeplessness at night, and loss of weight. These symptoms may persist for several days and may be provoked by what would appear to be perfectly safe doses, doses which have produced not the slightest visible effect on the skin. They are chiefly evinced by patients with glycosuria, pulmonary tuberculosis, asthenia after debilitating diseases such as influenza, coryza, or diphtheria, or in patients with unexplained pyrexia. In every case, without exception, where such symptoms were met with, the blood pressure, both systolic and diastolic, was low.

Observations of blood-pressures taken before and

just after a light bath showed that in the great majority of persons the systolic pressure is lowered from 8 to 10 m.m., while the diastolic pressure is either unchanged or is lowered 1 to 2 m.m.

In some of the tuberculous patients where the above symptoms developed it was deemed advisable to stop the light baths. In the asthenic type of patient minimal doses very gradually increased were found to produce quite different results, the malaise, etc. being replaced by a feeling of marked well-being and mental alertness. In such cases, however, the dividing line between a suitable dose and an overdose is very fine indeed and there is no safe margin for error. The following will serve as an example:-

Case R.C. (Female, 24). Tuberculous Iritis.

Four years ago had redness and pain in right eye. Lost sight in right eye in 12 months. Left eye commenced to trouble her in same way 6 months after the right. Left iris oedematous with small nodules present. No chest symptoms, but X-ray showed increased shadows at roots of lung. Treated at Birmingham Eye Hospital. Bad tuberculous history. Decided to augment local treatment from hospital by general ultra-violet radiation and in view of X-ray findings to give very small doses.

9.ii.25. - 1 min. at 4 feet to back and front of body was followed by langour and anorexia. No erythema of any degree noticed.

11.ii.25. - 1 min. at 4 feet - same result. B.P. 110 systolic; 64 diastolic.

13.ii.25. - Time reduced to ½ minute at same distance. Immediately patient felt brighter and more energetic and weight increased slightly.

By 18.ii.25 she had returned to 1 minute doses and by 25.ii.25 got to 2 minute doses, when faint erythema appeared. By 25.ii.25. she reached 3 minute doses and the hospital authorities reported improvement in the eye condition.

It is probable that ultra-violet radiation produces untoward symptoms in patients suffering from adrenal exhaustion, as indeed the diseases mentioned above seem to be followed by such a condition. Dr. F. Talbot in a letter to the British Medical Journal relates how an asthmatical boy was given an ultra-violet radiation bath and also his brother who was not asthmatical. Within some hours the first mentioned developed an attack of asthma and showed a much milder erythema than the brother. He was given adrenalin. Within half an hour the asthma has passed off and 3½ hours later it was observed that his erythema had increased and was now almost as marked as in the case of his brother. Dr. Talbot suggests that the skin's reaction to light makes a demand on the adrenals which in this case temporarily exhausted them and induced the attack of asthma and that the dose of adrenalin restored the balance and enabled the skin reaction to be completed.

Cataract. Burge[1] finds that coagulation of the crystalline lens occurs with exposure to ultra-violet radiation, even with wave-lengths of 2,800 - 3,020 Å.U. This coagulation was made evident, as in the case of white of egg, only in the presence of a 1% calcium chloride solution. The cornea transmits waves as short as 2,970 to 3,020 Å.U. An extract of lens 1 m.m. thick absorbs all waves shorter than 3,130 Å.U. On the other hand, the aqueous (1 m.m. thick) does not appreciably absorb the effective wave-lengths. Burge suggests that in glass-blowers' cataract the ultra-violet rays modify the lens protein in such a way that if abnormal amounts of calcium salts or silicate are present they combine to precipitate the protein and so produce a coagulum in the lens with resulting opacity.

In addition to glass-workers, cataract occurs in iron-smelters (Cridland) tin-plate workers (Healy) and chain-makers (Roberts).[2] It is very common in India where very bright sunlight is experienced.
These observers blame heat and suggest the use of goggles, but make no mention of the possibility of ultra-violet rays from the molten metals, etc. as being the true cause. This work of Burge is significant and at any rate strongly suggests that operators of ultra-violet lamps, particularly the modern, un-hooded quartz mercury burner, should exercise great care in

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1. Medical Annual: 1921. P. 93.
2. Ibid. 1922. P. 74. 75.

the protection of their eyes, lest in years to come "ultra-violet ray cataract" should claim its victims as did X-ray dermatitis.

Chicken Pox. P. Gautier[1] records two cases of severe varicella eruption on the shoulders which had been irritated by exposure to the sun.

A. Sack[2] reports a case of a child, 6½ years old, where he thinks ultra-violet radiation treatment "sensitised the skin" and aggravated the eruption to an extra-ordinary degree.

A. Reiche[3] refers to Sack's paper and says that he had 20 children who developed chicken pox while undergoing ultra-violet radiation treatment and in none of these was the attack more severe. Our own experience (3 cases) is that the eruption of chicken pox is distinctly benefited by ultra-violet radiation and that convalescence is hastened.

Menstruation. It was observed that women patients subjected to ultra-violet irradiation during the menstrual period were apt to complain of increased langour and malaise, whereas previously they had experienced a tonic effect from the rays. Hill and Eidenow[4] state that the bactericidal power of the blood is in many cases lowered during menstruation and that

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1. P. GAUTIER: Archiv. de Med: des Enfants. 657. 1919.
2. A. SACK: Munch: Med: Woch: 591. 1922.
3. A. REICHE: Ibid. 360. 1923.
4. HILL & EIDENOW: Pract. Aug. 1925. P. 109.

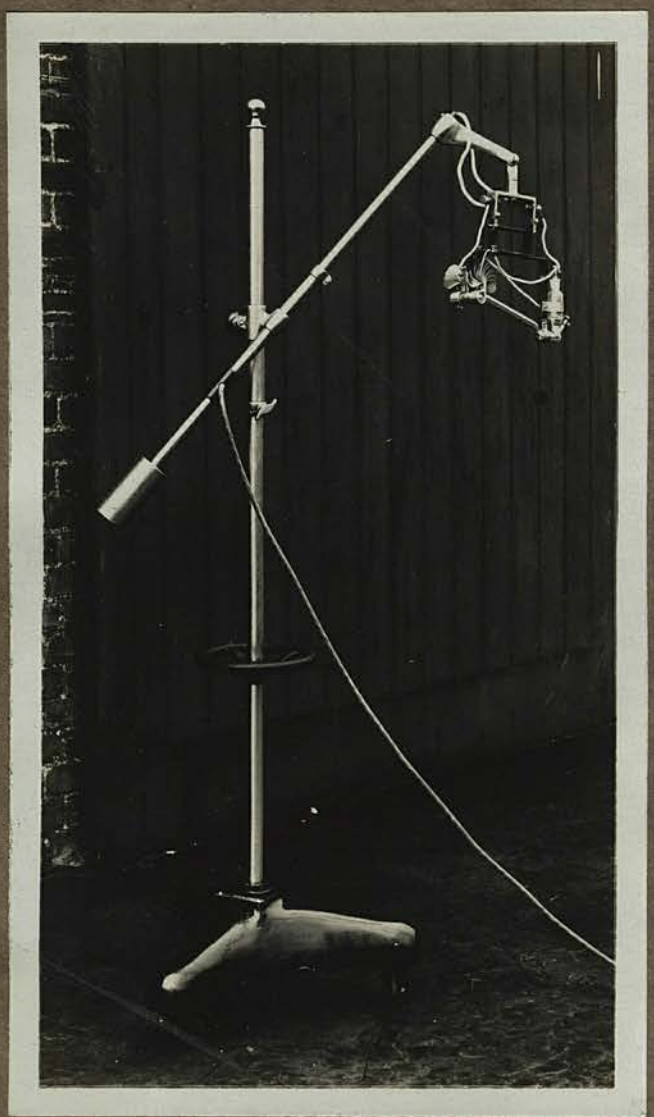
ultra-violet radiation treatment appeared to make this worse. It has been our practice to omit treatment for two days before the period and resume two days after, and women patients are warned to inform the nurse-in-charge at the clinic when the period is due.

Acute Infective and Pyrexial Cases. In the same article these observers record that in rabbits injected with bacteria to produce a septicaemia, the bactericidal power of the blood fell to a very low degree (10 per cent). Radiation of the skin in such conditions did not increase the killing power of the blood.

Our own experience with patients who developed pyrexial disturbances during treatment bore out the view generally held that the treatment by irradiation of acute affections accompanied by pyrexia should be undertaken with great care.

These remarks apply particularly to Pulmonary Tuberculosis. About 1913 the writer treated a chronic appendicectomy scar and sinuses - duration one year - very successfully with sunlight. A nurse, encouraged by this result, took upon herself the responsibility of placing a boy of 10 with active lung tubercle in a bright sun for some hours. The chest and back sustained a very acute solar dermatitis, the boy's temperature at once rose and remained high, and signs in the lungs were increased. He became very ill, developed acute tuberculous meningitis in a few days, and died.

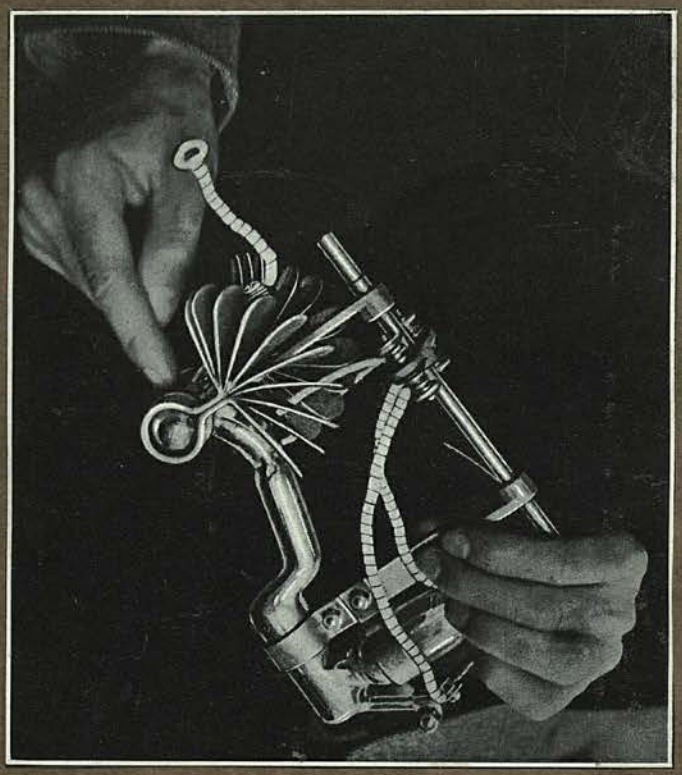
THE "K.B.B." MERCURY VAPOUR LAMP AND STAND.



QUARTZ MERCURY VAPOUR BURNER

"K.B.B. TPYE.

Showing reservoirs and radiating fins.



IV. - PRACTICAL USE OF THE ULTRA-VIOLET LIGHT IN A MODERN PUBLIC HEALTH DEPARTMENT.

(a) Clinic, Staff, and Equipment.

In September, 1924, the Light Clinic was inaugurated by the Smethwick Health Committee. Premises in the existing Clinic for Chest Diseases were used, including a waiting-room, consulting room, dressing cubicles, an office, and a treatment room. The temperature of the latter can be maintained at 68° to 70° F. by means of a gas fire.

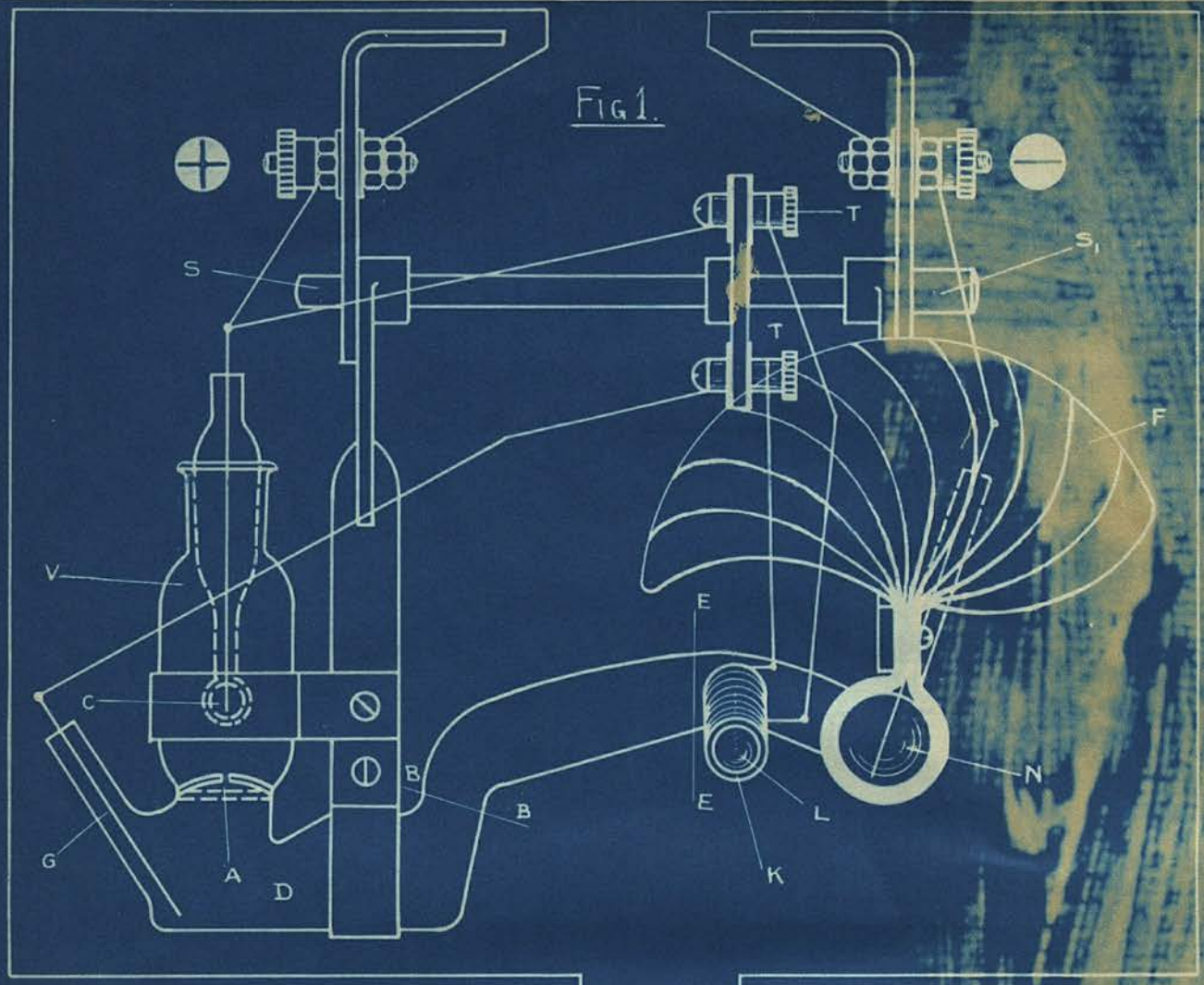
At first two sessions were held weekly, on Monday and Friday afternoons, but the popularity of this Clinic grew so rapidly and the benefits were so soon apparent, that seven sessions were introduced, and as many as 124 patients were attending, some bi-weekly, and some three times a week. Ante-natal mothers were given two sessions to themselves.

The staff consists of one medical officer and two nurses. A small revolving stool and chairs are provided.

Description of Apparatus Used.

The lamp used by the writer in the treatment of cases at the above clinic is known as the "K.B.B. Quartz Mercury Vapour Lamp." The assembly consists of the lamp and its stand, switch, a series resistance, and a voltmeter and amperemeter. This lamp works on a 220 to 250 Volt direct current circuit, being connected to a 5 ampere plug with the resistance in

FIG 1.



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- G. AUXILIARY ELECTRODE.
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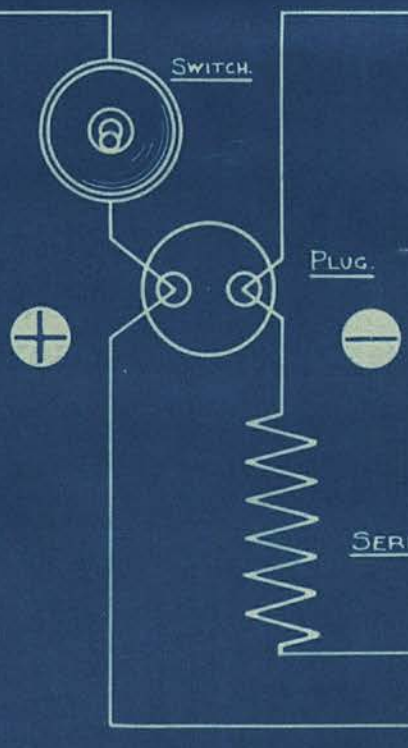
- L. LIMB.
- N. NEGATIVE RESERVOIR.
- SS_1 TRUNNIONS.
- T. HEATING COIL TERMINALS.
- V. VERTICAL RESERVOIR.



WIRING DIAGRAM OF QUARTZ MERCURY VAPOUR BURNER "INDUSTRIAL" TYPE.

KELVIN, BOTTOMLEY & BAIRD LTD

SK. Nº W.D.100.

W.J.G.S
29.7.24

series. Later a second similar lamp was wired in parallel and suspended from the ceiling, so that for general light baths, a patient could sit between the lamps and have the back and front exposed simultaneously, thus halving the time of treatment taken with one lamp only.

Diagram of Lamp.

The burner consists essentially of a fused quartz U-tube, one limb of which is hermetically sealed. The other is closed by a stopper carrying a tungsten electrode. The whole tube is filled with mercury. The arc is started by a small branch tube sealed into the body of the quartz burner and surrounded by a heating coil. When the circuit is closed by the switch the coil heats up, boils the mercury, and the arc is struck between the two liquid mercury faces. The arc lengthens, the mercury travels up the open end of the U-tube, and remains at a constant level determined by the constriction at the end of the arc tube. When this level is reached the heating coil used for starting is automatically cut out.

(b) Diseases Dealt With at the Smethwick Light Clinic.

It will be convenient to consider these under the various departments associated with the Public Health Service, namely, the Tuberculosis, Maternity & Child Welfare, and School Medical Departments. In addition to these, sundry other cases, referred by local doctors, came under our notice.

At the beginning of each section is given a Table showing the number of cases dealt with and the progress made under treatment. The left half of the table deals with cases who have been treated and discharged, and the right half summaries the cases who have had some considerable amount of treatment and are still continuing.

TUBERCULOSIS DEPARTMENT:

Fifty-two cases of tuberculosis came under treatment with ultra-violet radiation: of these 23 have been discharged and 29 are still continuing treatment.

TABLE SHOWING CASES (I) TREATED AND DISCHARGED, and (II) STILL UNDER TREATMENT

- TUBERCULOSIS DEPARTMENT -

	TREATED AND DISCHARGED.						CONTINUING TREATMENT				
	No.	Cured.	Improved.	I.	S.	Q. Worse. Died.	No.	Improving.	I.	S.	Q. Worse. Totals.
Tuberculous Adenitis.	6	3	2	1	-	-	10	6	4	-	16
Lupus.	2	1	1	-	-	-	9	8	1	-	11
Bone & Joint Tubercle.	4	1	3	-	-	-	1	1	-	-	5
Lung Tubercle.	11	-	4	2	1	4	3	1	1	1	14
Tubercle of Eye.	-	-	-	-	-	-	2	2	-	-	2
Tubercle of Peritoneum.	-	-	-	-	-	-	1	-	1	-	1
Bazin's Disease.	-	-	-	-	-	-	1	1	-	-	1
Scrofuloderma.	-	-	-	-	-	-	2	2	-	-	2
Totals.	23	5	10	3	1	4	29	21	7	1	52

NOTE:- Photographs presented are all of cases still undergoing treatment.
In comparing the pairs of photographs allowance must be made for pigmentation which tends to mask the improvement in the actual lesion.

(1) 12.i.25.

(2) 18.ix.25.

F.M. Aged 16 years. TUBERCULOUS ADENITIS.

Unsightly scars.

Tuberculous Adenitis (16 cases).

Hyperplastic forms yield rapidly to ultra-violet radiation, whereas the fibro-caseous type require long periods. Suppurating glands improve but take a considerable time. These glands were aspirated where possible. In those that had broken down the first sign of improvement was noticed in the infected skin edges which lost their bluish, unhealthy tint and became reddened and in time healed up with good cosmetic result. (See illustration on opposite page).

One case developed a suppurating gland, with reddened skin above, during the course of the treatment. This gland was irradiated for 5 minutes at 1 foot, and then under the lamp, was incised and ʒ ii pus gently expressed. The wound healed completely in 14 days and the skin remained healthy.

In almost every case the general condition of the patient improved definitely, and weight was gained in almost every case. During the first two or three weeks of treatment the weight may fall slightly. One case of tubercle in axillary glands responded particularly well.

Case F.R. Male 33 years.

In June, 1924, injury to left thumb, followed by left axillary abscess. Several operations were done, the condition being regarded by the surgeon as tuberculous. X-ray treatment was tried at the hospital. He was referred to us on 11.ii.25 and then had a raw, unhealthy surface in left axilla, with tags of bluish

LUPUS VULGARIS

H. M. Age 11 years. Duration: 3 years.
Commenced treatment: 19.i.25.
Total irradiation: 490 minutes.

(1) 20.vi.25.

(2) 16.ix.25.

LUPUS VULGARIS

F. F. Aged 8 years. Duration 1 year.

Commenced treatment: 22.v.25.
Total irradiation: 428 minutes.

(1) 20.vi.25.

(2) 16.ix.25.

LUPUS VULGARIS

H. H. Aged 7 years.

Commenced treatment: 12.i.25.

Total irradiation: 400 minutes.

(1) 19.i.25.

(2) 16.ix.25.

indolent-looking skin surrounding it, together with a sinus leading from the outer end of the left clavicle to the axilla. In addition he showed traces of a mild X-ray burn over his left shoulder and upper arm. He had been in bed for 3½ months, was miserable and thin and very depressed. At first he was brought to the Clinic in a wheeled chair and treatment commenced with a body bath of 2 minutes at 3 feet back and front and 1 minute at 2 feet to axilla. The exposures were gradually increased every second day to 4 minutes at 3 feet (bath) and 3 minutes at 1 foot to axilla. The X-ray burn rapidly cleared up and he improved all round from the first week's treatment. By 25.v.25 the axilla was healed with a good elastic scar and he had gained 8½ lbs. in weight. The most striking feature in his case was the change for the better in his general appearance and his increased cheerfulness. After the first 14 days treatment he walked to the Clinic. The surgeon who saw him at the Out-patients' Department of the Hospital found time to write and express his pleasure. Total irradiation: 168 minutes.

Lupus (11 cases).

In every case except one, improvement, continuous and marked, followed treatment. The resistant case was of the ulcerative moist type affecting the nose. The other ten cases were of the dry, scaly type. Axel Reyn, Sequeira, and numerous other observers, report satisfactory results in the treatment of this most

intractable affection. With combined light baths and local irradiation they claim 60-70% cures.[1] One's own experience confirms this statement, viz., that general irradiation combined with local irradiation secures more effective and quicker results than local irradiation alone.

Bone & Joint Tubercle (5 cases).

These included disease of elbow 1, sternum and ribs 1, knee 2, and spine 1, and had all received treatment for considerable periods at the Orthopaedic Hospital, except one (elbow). They were irradiated because after returning to their homes, they had commenced to fall off in general health. They all improved and the elbow case was cured with light treatment combined with splintage. A feature worthy of note in these cases is the improvement in the general bearing of the patients.

Lung Tubercle (14 cases).

These included 7 cases of active pulmonary tuberculosis with positive pputa and 7 cases of hilus tubercle. There were 4 deaths. It was soon evident that ultra-violet radiation is a powerful and possibly dangerous weapon in treating pulmonary tuberculosis. One man, W.B. aged 36, was found to be worse after his second treatment. Temperature rose to 101° F. the same evening and he felt languid and ill. Enquiry revealed

1. A. REYN: B. M. J. Sept. 22. 1923. P.500.

the fact that he was attending another doctor for irradiation, in the belief that he could not get too much of a good thing, and had informed neither of us of the fact. He continued to grow worse and died four months later. In my opinion, ultra-violet treatment caused a "flare-up" in this case.

A second case, C.W., male aged 26, had tubercle of both lobes of the left lung and infiltration of the right apex, with dysphagia. He developed glands in the neck the size of walnuts. Hearing of improvement in other cases of adenitis, he came asking for light treatment. He was advised against it, but persisted in coming. He had local treatment to neck glands only, on six occasions. He promptly lostweight and his condition seemed worse. He was sent to hospital and died six weeks later.

The third case who died had profound anaemia for which he was given light baths. He felt brighter but the anaemia was uninfluenced. Cause of death, which occurred two months later, was carcimona of liver.

The fourth case was transferred to a sanatorium after only four treatments, and had gained weight. He died later in the sanatorium.

Of the other T.B. cases, two gained weight and improved and one was worse.

Of the Hilus cases, 4 showed definite improvement, 2 are not, and one developed hysteria and was sent to hospital.

In attempting to treat any case of active lung tubercle the writer would advise great caution. Dosage should commence with short, daily exposure of arms at first, then arms and legs, later thighs, and after two or three weeks "preparation" in this way, short baths to whole body, gradually increasing according to reaction of patient.

In none of the above cases was an increased tendancy to haemoptysis observed, but the slightest overdose of light was followed by marked depression, and sometimes increase of cough, sweats, and loss of appetite.

Possibly further experience will show improved results in cases of pulmonary tubercle, particularly in "early" cases, but the writer soon found that results in other branches of the work were so encouraging that the case of pulmonary tubercle was not urged to attend the Clinic.

Tuberculous Peritonitis (1 case).

Mrs. N. aged 27.

June 26.24. In hospital for curettage. Had diarrhoea, constipation, vomiting, and debility.

Nov. 25.24. In hospital again and had a tuberculous appendix and ovarian cyst removed. Surgeon found tuberculous peritonitis.

Jan. 7.25. Referred to Smethwick Chest Clinic. No signs in chest. No chest symptoms. Anaemic, weak. No appetite. Abdominal pain at times. Abdomen

slightly tumid. No masses felt.

Ultra-violet radiation to abdomen to July 19. 25.

Total irradiation: 368 minutes.

By this time she had gained 6 lbs. and looked and felt better. She had a relapse, with pain in left iliac fossa, constipation and menorrhagia and lost 10 lbs.

Sept. 9. 25. Has resumed treatment and is again improving. Average dose 5 minutes at 2 feet to abdomen.

Tuberculosis of Eye, Bazin's Disease, and Scrofuloderma.

These cases are still under treatment and show considerable improvement.

The eye case (tuberculous iritis) was at first very sensitive to light (subjectively) see page 41.

BAZIN'S DISEASE

P.W. Female, aged 15½ years.

Duration: 6 years.

Commenced treatment: 29.ix.24.

Total irradiation: Legs - 128 minutes
Body - 442 "
570 "

(1) 24.xi.24.

(2) 18.ix.25.

SCROFULODERMA

Mrs. W. Aged 43 years.
Duration: 7 years.
Commenced treatment: 27.ix.24.

(1) 19.i.25.

(2) 16.ix.25.
Still under treatment.

TABLE SHOWING CASES (I) TREATED AND DISCHARGED, and (II) STILL UNDER TREATMENT.

- MATERNITY AND CHILD WELFARE DEPARTMENT -

	TREATED AND DISCHARGED						CONTINUING TREATMENT				
	No.	Cured.	Improved.	I.S.Q.	Worse.	Died.	No.	Improving.	I.S.Q.	Worse.	Totals.
ANTE-NATAL MOTHERS:											
Debility.	10	6	2	1	1	-	3	3	-	-	13
Insomnia.	2	2	-	-	-	-	1	1	-	-	3
Anaemia.	5	1	2	1	1	-	-	-	-	-	5
Total.	17	9	4	2	2	-	4	4	-	-	21
BABIES & TODDLERS.											
Malnutrition.	1	1	-	-	-	-	2	2	-	-	2
Rickets.	9	8	1	-	-	-	8	6	2	-	17
Not thriving.	7	-	5	1	-	1[x]	7	7	-	-	14
Bronchitis.	1	1	-	-	-	-	2	1	1	-	3
Peritonitis.	2	1	-	1	-	-	-	-	-	-	2
Total.	20	11	6	2	-	1	19	16	3	-	39

x Child feeble-minded. Died: Broncho-pneumonia.

MATERNITY & CHILD WELFARE DEPARTMENT.

Of the 56 cases reviewed, 21 were expectant mothers referred from the Ante-Natal Clinic for light treatment. The word "debility" is used perhaps unwisely on the record cards, and, as usual, covers a multitude of symptoms. In these cases it signified lack of energy, appetite, and feelings of depression and low-spirits in the expectant mother, sometimes accompanied by restlessness at night. Cases presenting definite insomnia are classified as such, as are cases of anaemia. Strangely enough some little difficulty was experienced at first in getting these ante-natal mothers to attend for irradiation, but by persuasion and taking care to keep well within the limits of a mild erythema dose, this diffidence was soon overcome and now the clinic is growing popular. Only 4 cases are shown as "continuing treatment" but many more have recently commenced to attend but have not attended long enough to be included in the figures.

This light clinic for expectant mothers has been available for a comparatively short period only, so that one has not enough experience to make emphatic statements. At the same time, the growing popularity of the clinic, and the appearance, improved cheerfulness, increased appetite and better mental outlook obtained even after the first three or four treatments, gives encouragement. Two of the mothers have since had fine babies and are breast-feeding them.

A striking result was the attainment of normal sleep soon after the treatment commenced.

The two cases returned as "In Statu Quo" ceased attending after only 4 treatments, i.e. two weeks. From what we know of the power of ultra-violet radiation to raise the bactericidal power of the blood and from a possible influence in aiding lactation, it seems well worth while to irradiate the expectant mother who is "below par", or where home conditions deprive her of sufficient air and exercise.

Babies and Toddlers.

The table shows that 39 were irradiated, the average period in the "Treated and Discharged" series working out at 150 minutes, total irradiation. At this clinic the babies attend three times a week. The mother holds the infant at 4 feet from the lamp in the first instance for 2 minutes for the back and 2 minutes for the front of the body. This is increased by a minute per week up to five or six minutes. Children who appear to stand the light well are then brought to 3 feet from the lamp. As a rule with this dosage little or no erythema is seen. Sometimes after 4 or 5 baths there is a slight transient erythema in some babies, and then on succeeding occasions no erythema.

The babies' eyes are protected by a bandage and the mothers and toddlers wear goggles. Many of the mothers expose their chests and arms to the light and volunteer the information that they feel more cheerful

and more energetic since bringing the baby to the light clinic.

It is difficult to restrain one's enthusiasm in writing about the effects of ultra-violet radiation in these babies and toddlers. Taking the milder abnormalities first, children suffering from malnutrition, simple gastric disturbances, fretfulness, nervous irritability, inadequate increase of weight for no definite reason, babies who do not seem to thrive - who "hang fire" as it were - respond at once and show most marked improvement. After the first three or four treatments the babies show a very definite increase of capacity for movement, movements are more vigorous, the babies are obviously brighter, more alert and more contented. The mothers report better nights and quieter sleep. Occasionally a "light-sensitive" child is met with, where even the mild dosage of ultra-violet radiation outlined above is followed by loss of appetite, fretfulness and nervous irritability, sometimes accompanied by drowsiness and sometimes by sleeplessness. These cases are moved 6 feet or more from the lamp, kept at the 2 minute dose, and brought gradually nearer at each sitting. All have responded to this method.

It would appear that very brief exposures are quite sufficient to produce satisfactory results in babies and young children.

RICKETS.

T. L. Male, aged 15 months.

Acute Rickets: (See Page 60, Text).

(1) 1.xii.24.

(2) 18.18.ix.25.

Discharged - Cured.

RADIOGRAPHS of Case T.L. 16 months.

ACUTE RICKETS

(1) 28.xi.24.

X-ray after three treatments, 16 min. irradiation. Ends of diaphysis are scalloped. Epiphyses are broadened and show osteoid tissue with a few isolated trabeculae of calcified bone. Dark line across the diaphyseal aspect of epiphysis of radius represents commencing deposit of calcium due to treatment. Shafts show rarefaction.

(2) 16.ii.25.

After 160 minutes irradiation. X-ray shows scallop line of new bone. In the epiphyseal aspect of diaphysis with increased deposition of calcium.

(3) 18.ii.25.

After 230 minutes irradiation. X-ray shows continued healing. The shafts of the bones are denser and a line of increased calcium deposit shows well in the sub-pereosteal bone. The epiphyses are well outlined and the deposit of calcium denser, and the egges show more clearly.

(4) 6.iv.25.

After 274 minutes irradiation. Shafts denser: outline of epiphyses well defined. Child clininoally cured.

Rickets.

Of the 17 cases treated, 15 showed progressive improvement all round. Of the two returned as "In Statu Quo" one is an illegitimate child with dreadful home surroundings and the other appears to be mentally defective. In the writer's opinion ultra-violet radiation is as specific in the cure of rickets as is cod liver oil and acts in a much shorter time. He is of opinion that ultra-violet radiation should be applied to every child in our industrial towns, especially during the winter months, and preferably in the first eight weeks of life, as a prophyllactic against rickets and spasmophilia.

Several babies were referred for treatment with evidence of slight rickets only but with delayed dentition. These cases responded well and soon after treatment the teeth erupted rapidly and satisfactorily.

Illustrative Cases:

T.L. Male, 16 months. Breast-fed to present time. Illiterate mother. Large head. Open fontanelle. Bronchitis. Unable to walk. 6 teeth.

19.xi.24. Ultra-violet radiation commenced. Weight 14 lbs. 9 oz.

1.xii.24. Child livlier and stronger. Less fretful. X-rays showed florid rickets.

22.xii.24. Sleeps well now. Sweats less. Cries less. Weight 15. lbs. 4 oz.

14.i.25. Improvement continued. Weight: 16 lb. 8 oz.

19.i.25. Slight bronchitis. Weight: 16 lb. 2 oz.

18.ii.25. Still slight cough but improving. X-ray showed increased calcium deposit. Weight: 17 lbs. 4 oz.

18.iii.25. Child very well and very active. X-ray showed dense calcium deposit. Weight: 17 lbs. 14 oz.

14.iv.25. Child quite well. Weight: 18 lbs. 7 oz.

15.v.25. Child quite well. Weight: 20 lbs.

Total irradiation: 130 minutes.

R.S. Male 7 months. Mother tuberculous. Bottle-fed. slight rickets. No increase in weight for six weeks. Bronchitis. No teeth.

18.ii.25. Ultra-violet radiation commenced. Weight: 16 lbs. 12 oz.

4.iii.25. Improving. No teeth. Weight: 17 lbs.

16.iii.25. Cut 2 teeth. Sleeps better. Better colour. Weight: 17 lbs. 11 oz.

17.iv.25. Child improving all round. 3 teeth. Weight: 18 lbs. 6 oz.

29.iv.25. 6 teeth. Weight: 19 lbs. 12 oz.

18.v.25. 7 teeth. Weight: 21 lbs. 8 oz.

12.vii.25. Child developed Whooping Cough. Lost 2 lbs. Two-hourly spasms day and oftener night. Ultra-violet radiation continued and after second week of the disease no whoop or vomiting occurred.

2.ix.25. Child firm and strong and lively. No sign. of bronchitis. Weight: 23 lbs. 6 oz.

Total irradiation: 478 minutes.

B.M. Female. 15 months. Rickets. Wide soft fontanelle. Poor appetite. Restless at night. Fretful. 2 teeth.

3.vii.25. Ultra-violet radiation commenced. Weight: 19 lbs. 2 oz.

12.vii.25. Appetite better. Weight: 20 lbs.

27.vii.25. Fretful. Gums sore. Teething. Weight: 19 lbs. 2 oz.

10.viii.23. Sleeps better. 5 teeth. Weight: 20 lbs. ¼ oz.

28.viii.25. Six teeth. Weight: 20 lbs. 7 oz.

14.ix.25. Child wery well and active. Wt. 20 lbs. 13 oz.

Total irradiation: 166 minutes.

R.V. Male. 9 months. Rickets. Bottle-fed. Fat and rather flabby. Open fontanelle. No teeth.

31.i.25. Ultra-violet radiation commenced. Weight: 16 lbs. 5½ oz.

9.ii.25. Vomiting feeds. Weight: 16 lbs. 6½ oz.

20.ii.25. Appetite better; keeps down feeds. Slight cough. Weight: 16 lbs. 4 oz.

27.ii.25. Child much firmer and healthier looking. Has now 12 teeth. Weight: 16 lbs. 4 oz.

Total irradiation: 48 minutes.

(1) 27.vi.25.

J.T.M. Male, 8 months. Child 9 lbs. at birth. Now 7 lbs. 12 oz. Throws up all feeds. Ultra-violet irradiation from 27.vi.25. to 4.vii.25. Vomiting less. Weight: 8 lbs. 2 oz. Sent to hospital as suspect pyloric stenosis. Discharged after observation with suggestion that spasm of oesophagus occurred. Baths being continued.

23.ix.25. Weight: 10 lbs. 4 oz. Child more contented and vomits much less.

FURTHER RADIOGRAPHS OF RICKETS

E.P. Female, 1¼ years. ACUTE RICKETS.

(1) 28.i.25.

Note marked expansion of ends of diaphyses and definite scalloping. Very broad, woolly epiphyseal areas representing osteoid tissue. Sub-pereosteal bone shows marked rarefaction and there is absopption of meshwork of the calcified bone.

(2) 10.vi.25.

After 124 minutes irradiation. Rickets now healing. Scalloped diaphyseal ends now show dense borders of new calcified bone. Epiphyseal outline is becoming regular and distinct. Sub-pereosteal bone is now dense, calcified and healed.

T.C. Male, aged 3½ years. ACUTE RICKETS

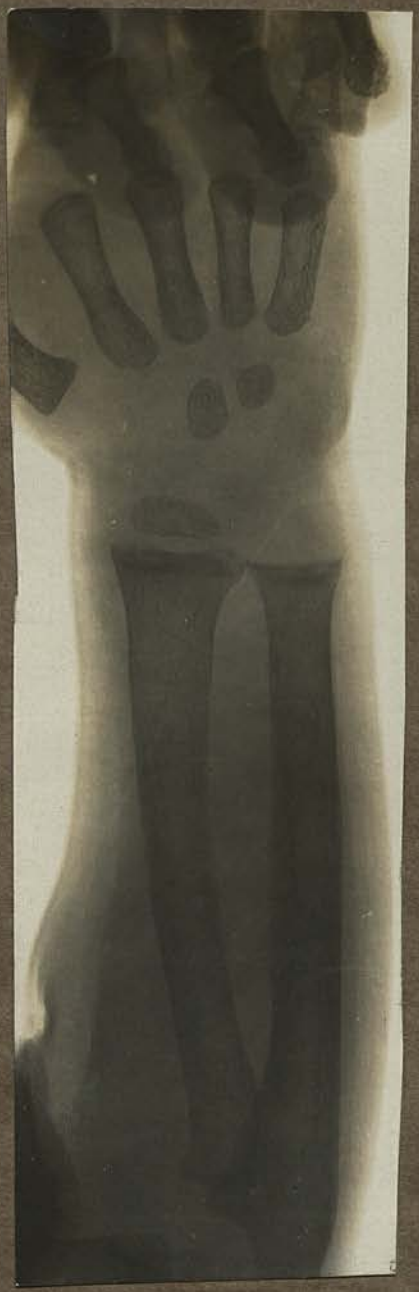
(1) 18.iii.25.

General rarefaction of all the bones of the hand and forearm. Expansion of the extremities of the diaphyses which are broad and ill-defined.on the epiphyseal side representing osteoid tissue. Ossified trabeculae are seen, especially in the metacarpals. Note the small amount of line in the epiphysis of the radius which is irregular in outline. Rarefaction of sub-pereosteal bone is present.

(2) 20.v.25.

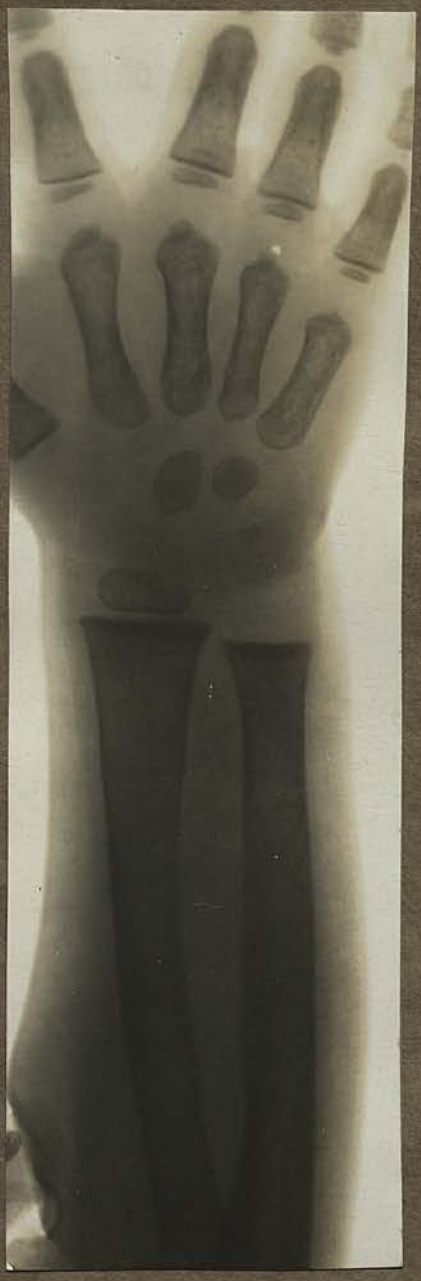
After 205 minutes irradiation. Shows healing rickets. Note dense border of epiphysis. Intense deposit of lime and scalloped edges of epiphysis. Thin, dense layer of new sub-pereosteal bone well shown in shaft.

R.C. Male, 1 year, 5 mths. HEALING RICKETS.



(1) 28.i.25.

This shows evidence of healing rickets of fairly short duration. Note that epiphyseal border of diaphysis is almost straight and no scalloping has occurred.



(2) 28.v.25.

After 175 minutes irradiation. New bone is dense and forms almost a straight line.

(Compare with print of normal, on next page.)

RADIOGRAPH OF NORMAL CHILD

Male - aged 8 months.

Whooping Cough.

Whooping-cough developed in the case of two infants while undergoing irradiation treatment. The treatment was continued and in both cases the writer felt that the disease ran a milder and much shorter course, the spasms ceasing at the end of two weeks. Dr. Ferdinand Schott,[1] of Cassel, gives details of 10 cases of whooping cough treated with ultra-violet radiation. In practically every case the spasms and vomiting ceased after 3 to 5 irradiations given at intervals of two days and doses of 3 to 5 minutes back and front. Success was obtained in every case. In three of the cases where the general health of the children was poor, the radiations were continued until 10 to 15 had been given, when the patients' general condition was markedly improved and resulted in complete recovery.

Action of Ultra-Violet Radiation in Rickets.

It may be stated quite definitely that ultra-violet radiation prevents rickets in babies and will produce successful cures in the same way that cod-liver oil will prevent and cure this disease. In connection with the prevention of rickets most valuable work has been done quite recently, and efforts have been made to ascertain what common element is present in the action

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1. F. SCHOTT: Deutschen Medizinischen Wochenschrift. No. 35. 1923.

of cod liver oil and ultra-violet radiation. Kuegelmass and McQuarrie[1] stated that cod liver oil and other anti-rachitic factors, when oxidised, gave off ultra-violet radiations. This was not accepted and was disproved by the experiments of Schultz and Morse[2], as a preliminary to their investigation of the spectroscopic properties of cod liver oil. That the anti-rachitic factor was due to Vitamin A in cod liver oil was believed for some time, but McCollom, Simmonds, Becker and Shipley[3] showed that in cod liver oil heated to 100° C. and aerated with bubbles of air, the Vitamin A was destroyed and yet the oil was still effective in preventing rickets.

In 1921, Wacker and Beck[4] pointed out that Cholesterol played a significant part in the anti-rachitic power of cod liver oil. Zücker[5] found that the active substance in cod liver oil was in the ether-soluable non-saponificable fraction of the oil.

Turning to the anti-rachitic properties of ultra-violet radiations Hess[6] found that the most active ultra-violet wave-lengths for preventing rickets lay from 3,000 to 3,130 Å.U. In a series of recent experiments

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1. KUEGELMASS & McQUARRIE: Science, 60, 272, 1924.
2. SCHULTZ & MORSE: Am. J. Dis. of Children. Aug. 1925. P.199. "Some Spectroscopic Observations on Cod Liver Oil."
3. McCOLLOM, SIMMONDS, BECKER & SHIPLEY: Bul. John Hopkins Hosp. 31, 221, 1922.
4. WACKER & BECK: Berlin Klin. Wchnschr. 18.453. 1921.
5. ZÜCKER: Proc. Soc. Exp. Biol. & Med. 20, 136, 1922.
6. HESS, A.F. & WEINSTOCK, M.: J. A. M. A. March 10, 1923. P. 687. "A Study of Light Waves in their relation to Rickets."

Hess,[1] Weinstock,[2] Steenbock[3] and Kramer have reported remarkable results in which they showed that anti-rachitic properties can be imparted to various previously inert fluids by ultra-violet radiation. These substances included cotton-seed oil, linseed oil, and chemical substances such as cholesterol and phytosterol. Kramer[4] fed 8 cases of rickets in infants with irradiated milk (10 to 20 minutes at 2 feet from the lamp) and concluded that healing was produced in every case.

Cholesterol is widely spread through the animal body and may be prepared from brain-substance.

Phytosterol is a main constituemt of the non-saponifiable fraction of vegetable oils, such as cotton seed oil.

Amongst other inert substances becoming anti-rachitic after irradiation, lard, muscle, dried milk, liver, and lettuce leaves may be mentioned.[5]

An interesting point emerges here, namely, that over-irradiation causes both cholesterol and phytosterol to lose their anti-rachitic properties, gained by a suitable dose of ultra-violet radiation.

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1. HESS, A.F.: Proc. Am. Ped. Soc. 36, 1924.
2. HESS & WEINSTOCK: Proc. Soc. Exp. Biol. & Med. 22, 5-6, 1924-25.
3. STEENBOCK, H. Science, 60. 224. 1924.
4. KRAMER: Am. J. Dis. Children. August, 1925. P.195. "Rickets in Children. Treatment with Irradiated Milk."
5. MACKAY, Helen, & SHAW, H.F. B. M. J. Aug. 22, 1925. P. 342. "Foodstuffs irradiated with Ultra-Violet Light: their effect on the bone lesions of Rachitic Children."

In both cases the anti-rachitic properties seem to be retained for long periods, once gained, especially in the presence of a vegetable or animal oil. Hess, Weinstock and Helman,[1] suggest the following hypothesis to explain the protection from rickets by sunlight or ultra-violet radiation:- The epidermis of the skin is plentifully supplied with cholesterol; solar rays and ultra-violet radiations "activate" this cholesterol and render it anti-rachitic; this activated cholesterol is transported by the circulation throughout the body. Rats on a rachitic diet were fed with irradiated skin and did not develop rickets, whereas control rats fed on non-irradiated skin did develop rickets.[2]

With regard to the ante-natal prevention of rickets, the idea has been prevalent that attention to diet enables the mother to store up sufficient anti-rachitic substances which will prevent rickets in the offspring.

Korenchevsky,[3] in his work on rats, rather supported this view, but Hess and Weinstock[4] in an

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1. HESS, WEINSTOCK, & HELMAN: J. Biol. Chem. 63. 305. 1925. "The Anti-Rachitic Value of Irradiated Phytosterol and Cholesterol."
1. also, Proc. Soc. Exp. Biol. & Med. XXII. p.227-228 1925. "The Development of Anti-Rachitic Potency in Phytosterol and Cholesterol following Irradiation.
2. HESS & WEINSTOCK: J. Biol. Chem. 64, 181, 1925.
3. KORENCHEVSKY, V. & CARR, M. J. Path. & Bact. 26,389, July, 1923. "The Influence of the Mother's Diet during Pregnancy and Lactation upon the Growth, General Nourishment, and Skeleton of Young Rats."
4. HESS & WEINSTOCK: J.A.M.A. Nov. 16. 1924. Vol.83. Pp. 1558-1562. "Rickets as Influenced by the Diet of the Mother during Pregnancy and Lactation."

elaborate enquiry into this subject concluded that rickets cannot be prevented by improving the diet of the mother (1) previous to pregnancy, (2) during pregnancy, or (3) throughout lactation, although it can be mitigated to a certain degree.

Further, infants could not be protected by giving the mother cod liver oil during the last two months of pregnancy as the active principle of cod liver oil is not excreted in the mother's milk.

It would seem from the above, therefore, that rickets is mainly of post-natal origin and our efforts for prevention must be directed mainly to this period.

The logical plan in our large cities and industrial centres would be to provide facilities for ultra-violet radiation at each infant welfare centre and endeavour to irradiate every infant for a short period, say within the first 8 weeks of life.

Dr. Palm, in the "Practitioner" as long ago as October, 1890, suggested "the systematic use of sun-baths as a preventive and therapeutic measure in rickets and other diseases". With modern conditionsof life in towns and crowded urban areas we are more than ever in need of sunlight; recent research has proved Palm to be right, and the modern Quartz Mercury Vapour Lamp provides the means by which such preventive measures could be easily, cheaply and successfully carried out.

In the case of female children, preventive irradiation would be productive of remote, as well as

immediate beneficial results, and would help materially in years to come to reduce the mortality of childbirth by a not inconsiderable extent. In support of this view, which at first sight may seem a little far fetched, one may refer to the measurements made by H. P. Ashby 1. in 150 normal children, and 150 rickety children:

Averages	At age 5 years.	At age 13 years.
External congugate in normal children.	4.8 in.	6 in.
External congugate in ricketty children.	4.1 in.	4.9 in.

He concludes that rickets in early childhood, allowed to continue, is the cause of the ricketty flat pelvis of the adult woman.

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1. ASHBY, H. P. B.M.J. Feb. 1922. 906.

TABLE SHOWING CASES (I) TREATED AND DISCHARGED, and (II) STILL UNDER TREATMENT

- SCHOOL MEDICAL DEPARTMENT -

	TREATED AND DISCHARGED.						CONTINUING TREATMENT.				
	No.	Cured.	Improved.	I.S.Q.	Worse.	Died.	No.	Improving.	I.S.Q.	Worse.	Totals.
Debility.	4	3	1	-	-	-	1	1	-	-	5
Catarrh & Bronchitis	3	3	-	-	-	-	1	1	-	-	4
Impetigo (face and scalp.)	3	3	-	-	-	-	2	1	-	1	5
Septic Sores.	3	2	-	-	1	-	-	-	-	-	3
Alopoecia.	2	1	-	1	-	-	6	3	3	-	8
Chorea.	5	4	-	1	-	-	5	5	-	-	10
Rheumatic Carditis.	-	-	-	-	-	-	1	1	-	-	1
Rheumatic Nodes.	-	-	-	-	-	-	1	1	-	-	1
Un-resolved Pneumonia	4	3	1	-	-	-	1	-	1	-	5
Osteomyelitis(legs) (Tender, unhealthy scars.)	1	-	1	-	-	-	1	1	-	-	2
Totals.	25	19	3	2	1	-	19	14	4	1	44

SCHOOL MEDICAL DEPARTMENT.

It will be seen from the table that 43 cases came under treatment. These cases were referred chiefly from the school clinics or from routine school medical inspection.

Debility.

Satisfactory results were obtained in debilitated children who seemed unable to put on weight or who seemed retarded in growth. Perhaps the most marked effect of ultra-violet radiation in these children was the increase in height noticed, and to a lesser extent the increase in weight. Weight sometimes fell during the first two weeks of treatment and then stedaily increased. There was also evidence of increased brightness in these children.

Skin Diseases.

In the common skin diseases of school life rapid improvement was noted, particularly in the child subject to impetigo, septic little sores, etc. Several children had ringworm of the body during treatment. Usually two local irradiations cured this condition.

Chorea.

Ten cases of chorea were treated and the results obtained were rapid, surprising and lasting. If these results can be obtained consistently in a large number of cases, a great saving will accrue to school attendance, for these cases are often out of school for many months at a time. The case returned as "In statu quo" was mentally defective.

Illustrative Cases.

A.S. Female, 10 years. Very nervous child. Afraid to cross road by herself. Twitching movements of right arm and leg. Enlarged, unhealthy tonsils. Heart sounds normal. Indolent blue scars in neck after operation for adenitis in 1923.

20.x.24. Ultra-violet radiation commenced. Ten minutes at three feet body. Height: 4ft. 3in. Weight: 4 st. 2¾ lbs. Irradiation continued bi-weekly.

24.xi.24. General condition improving. Chorea cured.

25.xii.24. Child no longer nervous. More robust. Weight: 4 st. 4¾ lbs.

9.ii.25. Discharged. Scars in neck healthy. Marked improvement in appearance and bearing. No sign of chorea. Not nervous now. Height: 4ft. 5in. Weight: 4 st. 7 lbs. Gained 4¼ lbs. and grew 2 inches.

Total irradiation: 252 minutes.

M.B. Female, aged 8. Marked twitching of right shoulder and head. Rolls eyes. Abdominal pains. Very nervous child. Drops things. Tonsils ragged. Heart normal. Duration: 6 months.

24.vii.25. Ultra-violet radiation commenced - 3 minutes at 3 feet, bi-weekly. Height: 4ft. 0in. Weight: 3 st. 8¾ lbs.

16.viii.25. More co-ordination and self-control. Weight 3 st. 8 lbs.

28.viii.25. No signs of chorea now.

16.ix.25. Discharged. Child quite well.

Height: 4ft. 0¾in. Weight: 3 st. 7¾ lbs.

Total irradiation: 114 minutes.

Bronchitis and Post-Pneumonic Conditions.

Certain of these children keep absenting themselves from school and despite drugs from their doctors and emulsions, do not seem to make any progress. Ultra-violet radiation treatment in the small number dealt with produced very definite improvement in 8 out of 9 treated.

Case E. S. Female, aged 11 years 8 months.

Child had pneumonia right side early in 1924. Since then has had constant cough and expectoration. Very thin, pallid and listless. Poor appetite. X-ray screen examination showed a marked fibrosis at right base, and dinimished movement of right diaphragm.

10.xii.24. Ultra-violet radiation commenced, 3 minutes at 3 feet. Height: 4ft. 7in. Weight: 4 st. 11¼ lbs.

5.i.25. Improving. Weight: 5 st. 1 lb.

26.i.25. Improvement in appearance. Wt. 5st. 3 lbs.

4.ii.25. Grandfather wrote to clinic commenting on increased energy and the cessation of cough.

16.iii.25. Discharged. Appearance quite transformed. No cough. Expansion at bases good. Right base normal, except for slight harsh inspiration. Ht: 4ft. 9in. Wt: 5st. 6 lbs.

Gained 8¾ lbs. in weight and grew 2 inches.

Total irradiation: 190 minutes.

14.ix.25. Inspected. Now a big, sturdy girl; very well. Height: 4ft. 9½ in.
Weight: 6st. 1½ lbs.

I.M. Female, aged 5 years & 11 months.

History of recurrent "colds" and three attacks of "Broncho-pneumonia". Last attack left side Nov. 1924. Diminished expansion left side and numerous sibilant rhonchi. Off school 4 months.

		Height. ft.	in.	Weight. st.	lbs.
9.xii.24.	Ultra-violet radiation commenced - 3 minutes at 3 feet.	3	9	3	2¾
31.xii.24.	Improved. Cough less. More energy.			3	5
21.i.25.	Returned to school.			3	5¾
24.ii.25.	Cough almost ceased. Livlier. Appetite better.			3	7¼
2.iii.25.	Slight relapse. Off school for 14 days.			3	5¼
1.iv.25.	Improvement renewed and continued.			3	6½
4.v.25.	Improvement continued, and so on to -			3	7½
18.v.25.	6 minutes at 3 feet back and front.				
22.vi.25.	Discharged. Very well. No symptoms. Chest expansion equal both sides now. No signs in lung. Whole appearance healthier and child noticeably brighter and more lively.	3	9¼	3	7¾

Gained 5 lbs. in weight, and ¼ in. in height.

Total irradiation: 348 minutes.

Alopoecia.

These cases are very distressing in school children and involve the child in much ridicule from its school fellows, expecially where the loss of hair is complete, even to eyebrows and eyelashes. Moreover, when one attempts to treat the more severe cases, all sorts of efforts are rewarded with little or no result.

Now ultra-violet radiation certainly stimulates the growth of certain hairs. When the male operator first starts using ultra-violet radiation he finds that his beard grows most uncommonly rapidly on those days on which he manipulates the lamp. And next morning his razor is called upon to deal with a more than usually resistant stubble. This fact is obvious to the most casual observer. Smarting of the face is also present at first, but this wears off after a time. The stimulation of the beard persists however,

The course of Alopoecia Areata is so capricious that it is difficult to judge the real value of any treatment. Results appear to bear some relation to the duration of the alopoecia. At any rate, in a recemt alopoecia, hair is likely to appear more quickly than in a case of longer duration.

In endeavouring to restore vigour to the scalp we try to improve the blood supply by friction, massage, stimulating lotions, etc. With ultra-violet radiation we may safely and repeatedly produce an intense erythema far ahead of any similar effect obtained by heat or drugs. In treating alopoecia a sharp erythema of the third degree repeated once a week or in 10 days seems to produce the best results. The burner is placed 6 - 8 inches from the bald patch and exposures of from 10 to 20 minutes are given. Greasy scalps stand very long exposures without undue reaction. The aim is to produce an intense hyperhaemia and to stop short of blistering. At first it

is noticed that the hair stops falling so fast, and then falls not at all. For a time, possibly weeks, nothing further is seen and then fine downy hairs begin to show. Examined under the microscope, these hairs are seen to be about one-tenth part the diameter of a normal hair and have pointed ends: that is to say, they are new hairs. Often the first sparse crop and possibly even a second crop, falls out and finally the hair grows definitely.

Eight cases in all have been treated in school children - 4 girls and 1 boy with alopoecia areata, and 2 boys and 1 girl with complete baldness. Of these 8 cases, one was cured, 3 show definite improvement, and 4 are still in statu quo.

Illustrative Cases.

E. E. Female, 5 years. Alopoecia Areata.

Falling of hair commenced 4 weeks ago. Large bare patch from crown to occiput. Hair thin and still falling. Cause unknown.

6.i.25. Ultra-violet radiation commenced. Wt: 2st.11¼lbs.
19.i.25. Hair stopped falling; no new hairs on patch.
16.ii.25. Child as before. Ceased to attend. Wt. 2st. 12¾lbs.
19.ix.25. Visited. Nurse reports that hair grew 4 weeks after last visit and scalp now covered with a profuse growth.

M.S. Female, aged 9 years and 6 months.

Complete Idiopathic Alopoecia. Splendid hair till Feb. 1922, when it commenced to fall out, at first round occiput and then all over. By March, 1922, she was completely bald. No eyebrows: no eyelashes.

3.xi.24. Ultra-violet radiation commenced. Ht: 3ft.10in. Weight: 3st. 5¾ lbs.
12.i.25. Eyebrows growing. No sign of hair on head.

6.ii.25. Eyebrows and eyelashes growing well. No sign of hair on head.
6.vii.25. A few fine hairs on scalp over crown.
10.viii.25. Thin crop fell out.
16.ix.25. Normal eyebrows and lashes. No sign of further hair on scalp.
Height: 4ft. 0½in. Weight: 3st. 8¾ lbs.
Treatment continuing.

G.C. Male, ages 12 years.

Complete Idiopathic Alopoecia. (Illustrated)

Boy as bald as an egg. No eyebrows; no eyelashes. Lost all his hair at age 7 years.

29.ix.24. Ultra-violet radiation commenced weekly: scalp and occasionally general bath.
Height: 4ft. 7½ in. Weight: 5st. 2 lbs.
10.xi.24. Fine sparse hairs on scalp. Very fair in appearance.
5.i.25. These fell out.
2.iii.25. New crop of fine hairs on scalp. Eyebrows and eyelashes show slight irregular growth.
15.vi.25. Fine hairs more numerous. A few long, fine hairs on scalp.
24.viii.25. Scalp covered all over with fine hair ¼in. long. Eyebrows and eyelashes growing well and evenly. Continuing treatment.
Height: 4ft. 11 in. Weight: 5st. 12 lbs.

(Note: Second photograph shows these fine hairs if inspected closely.)

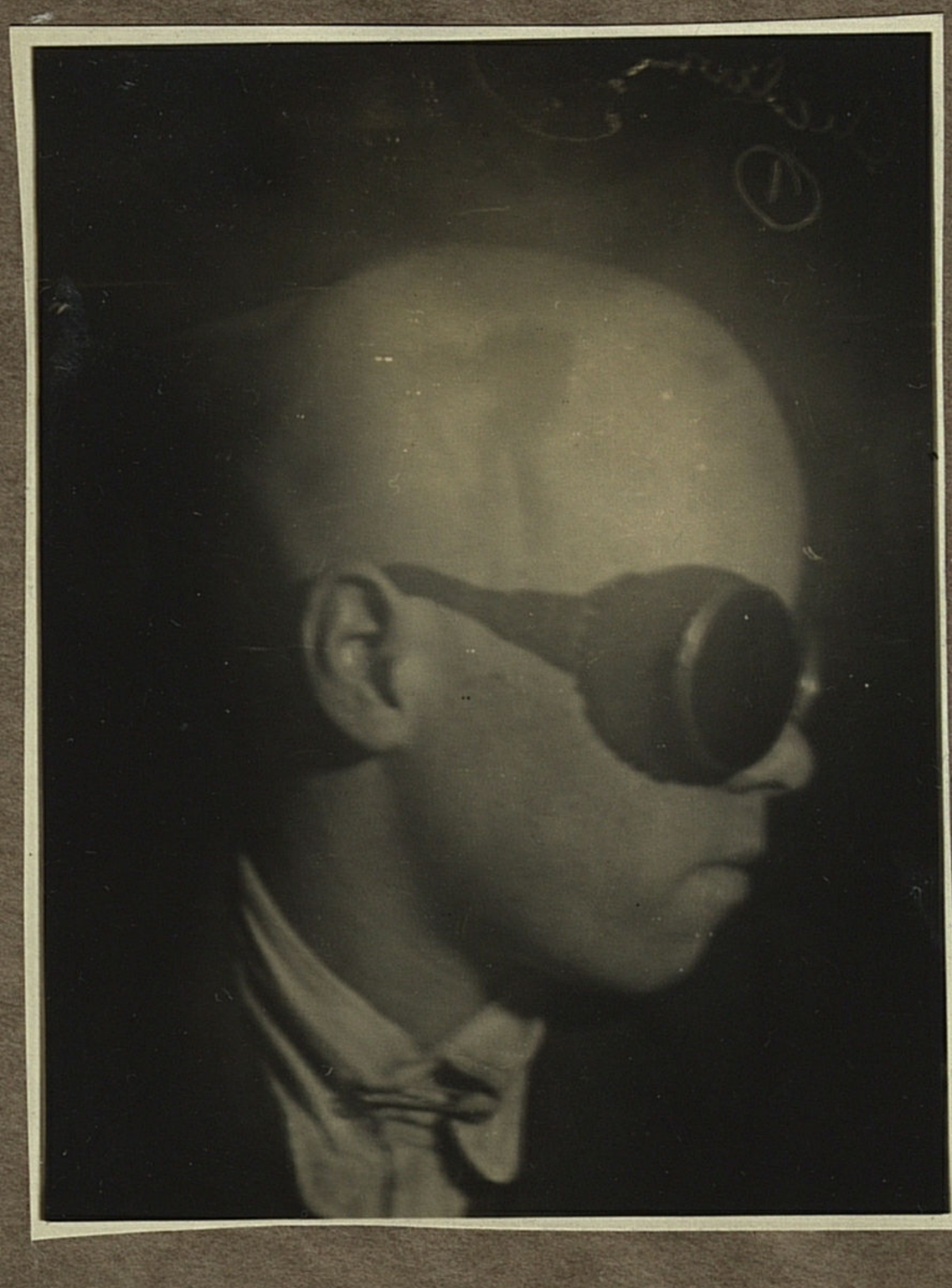
F. J. Male, aged 9 years. Complete Alopoecia.

Had ringworm of scalp at age 7. No X-ray treatment, but hair all fell out. No eyebrows; no eyelashes.

27.iv.25. Ultra-violet radiation commenced.
Height: 3ft. 11 in. Weight: 4st.
4.v.25. No effect seen till this week, when eyelashes appeared on right eyelids. No hair on head.
11.v.25. Pause due to Measles.
16.vi.25. Eyelashes and eyebrows growing well on both sides. A few fine hairs at sides of scalp appearing.
16.ix.25. Eyebrows and eyelashes very satisfactory. A few fine hairs on scalp still present and growing. Continuing treatment.
Height: 4ft. 0¾in. Weight: 4st. 2½ lbs.

COMPLETE ALOPOECIA

G.C. Aged 12 years. (See page 76).



(1) 10.xi.24.

(2) 16.ix.25.

Still under
treatment.

I.C. Female, aged 9 years. Alopoecia Areata - severe.

Hair began to fall at the age of 4 to 6 months. Numerous large bare patches now. Hair thin and falling very markedly. No eyebrows. Has eyelashes. Cause not known.

26.i.25. Ultra-violet radiation commenced. Height: 4ft. 3½in. Weight: 4st. 8½ lbs.
23.ii.25. Hair falling out less.
8.v.25. Hair ceased falling out. No new hair yet.
10.viii.25. Eyebrows starting to grow.
16.ix.25. No hair on bare patches. No further falling. Eyebrows growing strongly. Height: 4ft. 5in. Weight: 5st. 1¾ lbs. Treatment continuing.

In addition to these children, four members of the Town Hall staff attended for treatment for falling of the hair and threatening of premature baldness - two on the crown of the head and two on the forehead. These cases had several months' treatment and in every case the falling of the hair ceased. In three out of the four, fine new hair commenced to grow.

If brushings and combings are collected and weighed on a chemical balance weekly, the cessation of falling process under ultra-violet radiation treatment can be readily demonstrated. It will be noted that a decrease in amount lost occurs after washing, probably due to mechanical loss of hair during the washing process, which hair is not collected.

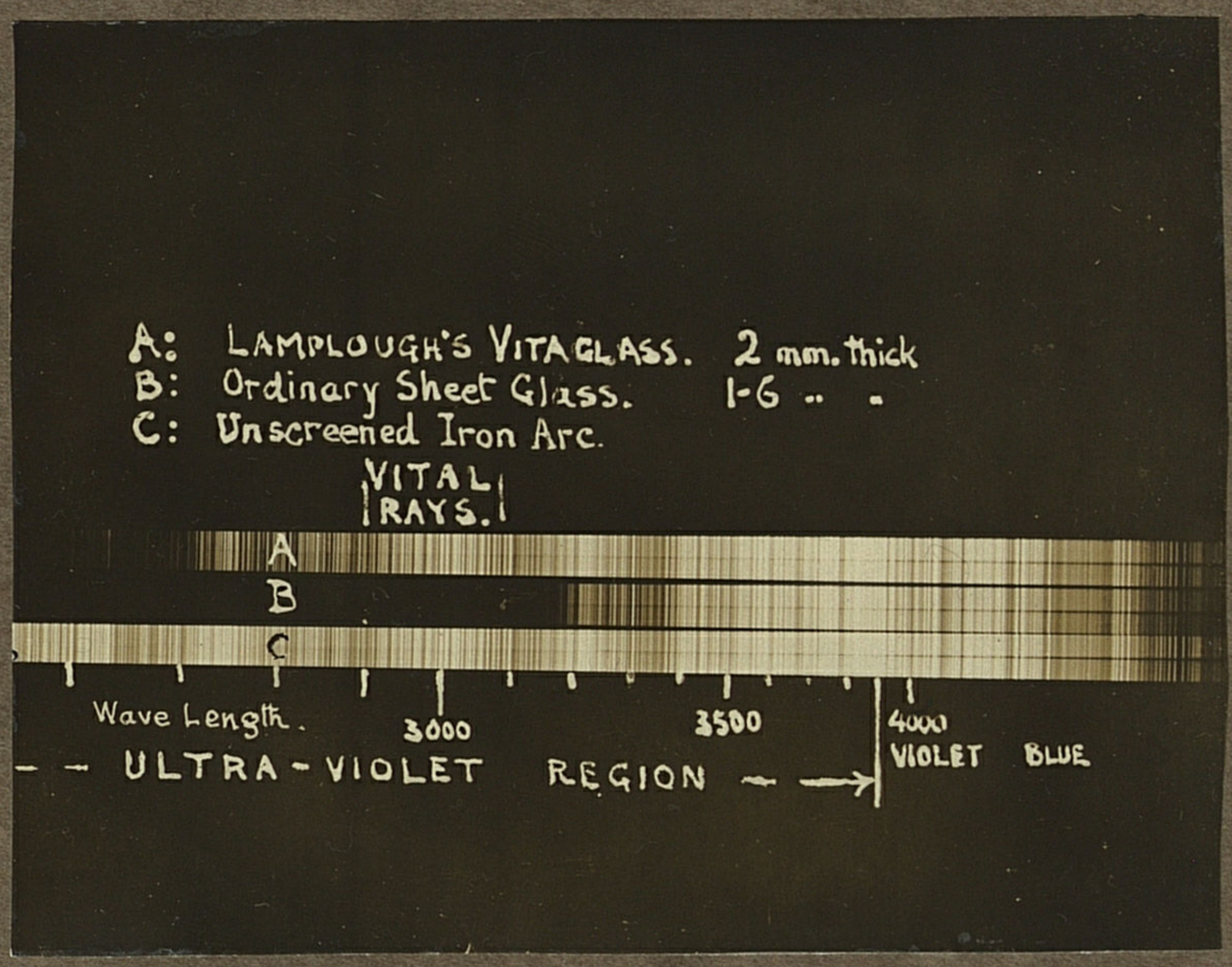
Illustrative Case: Miss K. aged 32.

1st.	week	- 0.76 grm.		7th.	week	- 0.65 grm.	(wash)
2nd.	"	- 0.45 "		8th.	"	- 0.27 "	
3rd.	"	- 0.64 "	(wash)	9th.	"	- 0.45 "	
4th.	"	- 0.24 "		10th.	"	- 0.58 "	
5th.	"	- 0.65 "		11th.	"	- 0.35 "	
6th.	"	- 0.60 "		12th.	"	- 0.25 "	

and remained at 0.25 grm. on average.

LAMPLOUGH'S VITAGLASS

Spectrum photograph, showing the composition of light from an electric arc between two iron poles.



A. Light of iron arc passed through VITAGLASS 2 mm. thick.

B. Light of iron arc passed through ordinary glass 1.6 mm. thick.

C. Light of iron arc, without screen.

"A" shows that Vitaglass transmits the vital rays to the extreme limit (wave-length 2,900) of the sun's spectrum.

"B" shows that the vital gays are completely obstructed by ordinary window glass.

V. - VITA-GLASS.

The writer would like to call attention to one other possibility in connection with the utilisation of ultra-violet rays of solar origin, which may have a far-reaching effect in School Medical Work.

Ordinary glass, as we have seen, cuts out ultra-violet radiations almost completely - at any rate waves shorter than 3,100 Å.U. do not pass, although the room may appear to be flooded with sunshine. Rays below 3,100 Å.U. appear to be the "vital rays" - valuable rays intimately associated with metabolism and growth.

Our school children are shut indoors for many hours a day within brick walls, in classrooms with ordinary glass windows which effectively rob them of even the relatively small amount of ultra-violet rays available in winter or summer in our smoke-enshrouded cities and towns.

Mr. F. E. Lamplough has invented a glass which he calls "Vitaglass" and which is manufactured by Messrs. Chance Bros. & Company, of Smethwick. Reference to the spectrograph on the opposite page will show that this glass allows to pass ultra-violet rays down to 2,750 Å.U. The source of ultra-violet radiation here is the iron-arc and the spectrum of this arc (A) is compared with (B) screen of Vitaglass and (C) ordinary window glass.

This glass will be most useful in schools, hospitals (particularly children's hospitals), nurseries,

sanatoria, verandahs, tungsten filament lamps, etc.

In June, 1925, the writer persuaded the Smethwick Education Committee to instal this glass in a class-room in one of the local schools. Boys of 9 to 11 years were taken and arrangements have been made to keep 25 boys in this class-room for 12 months. A control group of boys occupy an adjoining class-room with a similar aspect. The heights and weights of these two groups have been taken, together with haemoglobin estimations and it is proposed to repeat these observations at the end of the twelve months.

S M E T H W I C K on a dark week-day.

SMETHWICK on Sunday

when factories are at rest.

TABLE SHOWING CASES (I) TREATED AND DISCHARGED, and (II) STILL UNDER TREATMENT

- OTHER CASES -

	TREATED AND DISCHARGED.					CONTINUING TREATMENT.				
	No.	Cured.	Improved.	I.S.Q.	Worse.	No.	Improving.	I.S.Q.	Worse.	Totals.
Acne.	2	1	1	-	-	-	-	-	-	2
Boils.	1	-	1	-	-	-	-	-	-	1
Lumbago.	1	1	-	-	-	-	-	-	-	1
Neuritis.	2	1	1	-	-	1	1	-	-	3
Tri-geminal Neuralgia.	1	1	-	-	-	-	-	-	-	1
Bronchitis.	-	-	-	-	-	1	-	1	-	1
Chronic Eczema of Feet.	-	-	-	-	-	1	1	-	-	1
Psoriosis.	-	-	-	-	-	2	-	2	-	2
Debility after Influenza.	6	-	5	1	-	-	-	-	-	6
Chronic Bronchitis.	-	-	-	-	-	1	-	1	-	1
Keloid in Scars.	1	-	1	-	-	1	1	-	-	2
Varicose Ulcers.	-	-	-	-	-	1	1	-	-	1
Totals.	14	4	9	1	-	8	4	4	-	22

VI. - OTHER CASES.

Certain other conditions were referred for treatment by medical men in the town. Amongst these were the following:-

Acne (2 cases).

J.O, Male, aged 37. Marked Acne Vulgaris on chest and back. Duration - 20 years.

30.xii.24.	Ultra-violet radiation commenced. 3 minutes at 3 feet back and front, which produced in this case mild erythema reaction of the first degree.
10.i.25.	Third irradiation. Acne decidly improving.
17.i.25.	Fourth irradiation. Acne almost gone.
8.ii.25.	Acne cured after seven treatments.
5.v.25.	Inspected. No sign of relapse.

V.P. Female, aged 19. Acne on forehead and on lower face and chin. A few spots on shoulder. Duration - 5 years.

23.iii.25.	Ultra-violet radiation commenced. 3 minutes at 3 feet bath; 3 minutes at 2 feet face.
27.iv.25.	Slight improvement upper face. Dose 5 minutes at 1 foot.
29.v.25.	No further improvement. Chin i.s.q. Slight loss of weight.
26.viii.25.	Discontinued treatment. Acne not improved on chin, but cleared up on forehead and back.

Boils. (1 case).

M. Aged 30. Doctor. Numerous crops of boils on neck. Patient "run-down". Urine clear.

22.i.25.	Ultra-violet radiation commenced - baths and local application to boils with compressor of quartz glass.
20.ii.25.	Individual boils improved, but fresh crops keep appearing.
12.iii.25.	Boils cured. Progress not satisfactory with ultra-violet radiation in this case.

Neuritis (2 cases).

G.H.K. Male, aged 45. Doctor. Severe neuralgia down right arm and round to right scapula. Unable to hanf hat on peg owing to pain. Disturbed sleep.

5.i.25. Ultra-violet radiation commenced. Complained of increase of pain during irradiation and also at several subsequent sittings. Pain almost ceased 12 hours later after erythema developed. Then returned within 24 hours, but less severe.
11.i.25. Still pain right arm, but less severe. Ultra-violet radiation to body and locally to arm.
18.i.25. Pain almost quite gone. (Fourth dose).
8.ii.25. Pain gone.
26.iii.25. Pain gone. Very pleased with result and stated that relief from pain was noted in about 12 hours from the earliest dose. No marked erythema was produced except with first dose. Ten treatments.

Mrs. S. Aged 34. Cannot extend head without pain. Neuritic pains over right scapular region for some years.

19.xii.24. Ultra-violet radiation to body, back and front. Feels relief from pain, but complains of being irritable and languid after baths.
16.i.25. Pain in right shoulder less.
30.i.25. Sixth treatment. Can extend head backwards and to the right without pain - first time for years. Patient here said she was always sensitive to sunlight and as she felt languid and irritable after ultra-violet radiations, treatment was stopped.

Tri-geminal Neuralgia.

Mrs. P. aged 45. History of severe shingles in 1914 involving area supplied by 5-7 dorsal roots. Lasted six weeks and was very painful. In 1915 developed severe neuralgia of right side of face. From Zygoma down the whole right side of face was very tender and the slightest draught caused intense pain.
Treatment: Had all teeth removed; antra explored and drained; nasal septum straightened; tonsils removed; Condition defied all treatment and patient was worn and ill. Removal of Gasserian Ganglion was contemplated. Referred with above history by her own doctor for trial of ultra-violet radiation.

25.iii.25. Ultra-violet radiation commenced, 3 minutes at 3 feet body, and 3 minutes at 4 inches face.
30.iii.25. Pain less.
3.iv.25. Pain gradually lessening.
17.iv.25. Pain much less frequent. A few hours respite from pain.
4.v.25. No pain for a week at a time - the first time she has been quite free from pain in the Winter for 11 years.
22.v.25. Cold winds. Return of pain. Hyperaesthesia now only present on right side of nose and over a small area on right malar prominence.
16.vi.25. Pain gone again. Treatment continued.
22.ix.25. No further relapse. Patient is hardly recognised by neighbours so much have her appearance and expression improved. She is slightly thinner, livlier and gets out and about more.

Total irradiation: 441 minutes.

The analgesic effect of ultra-violet radiation shows itself in these cases from the earliest doses and comes on within 12 hours of irradiation.

In the last case quoted, mild general light baths were given, but severe third degree local reactions were produced on the right sidd of face.

Post-Influenzal Debility (6 cases).

Definite improvement occurred in 5 of these cases after 5 or 6 light baths. The case returned as "I.S.Q." got a fresh attack of Influenza after the tenth treatment and did not come back.

Great care must be exercised in dosage in these cases and the blood-pressure should be taken in these and in all cases in fact, before starting ultra-violet radiation. Usually the blood-pressure readings are decidedly low and small doses at short intervals - say two days - produce the best results. Erythema should be avoided and if the patient complains of increased

VARICOSE ULCERS

Mrs. K. Aged 36 years.
Commenced treatment: 14.viii.25.

(1) 28.viii.25.

(2) 16.ix.25.

langour or irritability the dose should be at once reduced. In one or two cases doses of 1 minute at 4 feet were found to be necessary. Any attempt to exceed this produced malaise. As the patients improve the dose can be gradually increased.

Keloid (1 case).

G.E.A. Female, aged 31 years. Re-vaccinated in 1921. Bad arm. Left blusih, much raised, unsightly scars. Patient sensitive to ultra-violet radiation when given baths. Local reaction fourth degree with quartz glass compressor produced on the scar areas every three weeks. After 11 applications, scars much reduced in size, not so raised, and bluish colour replaced by red. Small areas white and soft. Treatment continuing.

Varicose Ulcers of Leg (1 case). Illustrated.

Mrs. K. aged 36 years. Two varicose ulcers of left leg, which have never healed in 5 years. Recently spreading and causing pain, and patient unable to walk.

14.viii.25.	Ultra-violet radiation, 2 minutes at 2 feet locally. Weight: 10st. 12 lbs.
17.viii.25.	Reports that pain in leg is much less.
19.viii.25.	Ulcers healthier colour and granulations appearing on surface.
24.viii.25.	First photograph taken. Definite improvement. Dose now 7 minutes at 1 foot.
16.ix.25.	Second photograph taken. No pain now. Great improvement. Can walk well. Weight: 11st. 2½ lbs.

(Treatment continuing. Patient unable to rest leg as she should owing to home circumstances, yet healing is taking place.)

Psoriasis (2 cases).

D.H. Female, aged 17 years. Lesions marked on trunk front and back. Duration 10 years. Ultra-violet radiation has produced no evidence of improvement after 186 minutes total treatment, although general physical condition has improved.

L.W. Female, aged 14 years. Duration 3 months. Chiefly on chest and back, slightly on limbs. Total irradiation 360 minutes. No improvement, although general physical condition improving.

Removing scales and touching with 1% Eosin did not sensitise the lesions in any way.

Lumbago and Rheumatic Torticollis.

A man, aged 38, subject to lumbago and usually laid low for 10 or 14 days, was irradiated for 5 minutes at 1 foot over dorso-lumbar region. Next day an intense third degree erythema appeared. Lumgabo was gone and he was back at his work as an electrician. A sanitary inspector had a severe torticollis. Five minutes irradiation at 1 foot to the affected area produced a third degree erythema and he was cured next day.

VII. - CONCLUSIONS.

I. Research has demonstrated that exposure to ultra-violet radiation has a direct bactericidal effect on the surface of the skin.
In addition, certain definite indirect effects are produced:
(a) Increase in the bactericidal power of the blood.
(b) Increased retention of calcium and phosphorus and iron in the body.
(c) Stimulation of cell-metabolism.
(d) Analgesic effect on the skin.
(e) A general "tonic" effect.

II. Despite much valuable research on ultra-violet rays the exact method by which these invisible rays act on tissue and tissue fluids is not yet known. The well-defined latent period between exposure and the response of the skin by the production of an erythema is still unexplained.

III. While many observers lay great stress on the production of erythema in the treatment, both local and general, of disease, the writer has demonstrated that quite definite and satisfactory results may be secured without the production of erythema. In many local conditions he agrees that the duration of treatment may be curtailed by the production of a sharp erythema, especially in diseases where a roborifacient effect is desirable.

IV. Ultra-violet radiation seems to bring metabolic processes to a normal level, paradoxical as it may at first sight appear, whether these processes are above or below normal.

V. Ultra-violet radiation, used with patience and care, is capable of:

(a) A direct bactericidal effect on surfaces and fluids.

(b) A detoxicating effect on certain toxins.

(c) Increasing indirectly the resistance of the body to infection, by raising the bactericidal powers of the blood.

(d) Acting as a remarkably effective roborifacient and counter-irritant.

(e) Acting as a powerful analgesic on skin surfaces.

(f) Stimulating metabolism of the body, particularly the mechanism associated with growth in young children.

(g) Depressing the body metabolism if large or unsuitable doses are given, particularly in febrile cases, or in asthenic persons. In these cases the estimation of the blood-pressure gives useful information as to dosage and progress, a practical point not brought out in the literature.

(h) Aiding mineral metabolism of the body, especially in young children, and especially in relation to calcium, phosphorus, and iron.

VI. An agent which will secure such beneficial reactions as those outlined above, is particularly adapted for use in every modern Public Health Department.
From infancy onwards, our children are starved of light in our smoke-enshrouded towns. Light is intimately associated with growth processes and yet at the age of five years, or even earlier, just when growth is most active and light most needed, we shut up our children in unhygienic schools during hours when sunshine is available. Comment is hardly needed when one states that the greatest incidence of disease in children coincides with the time when they enter upon school life.

VII. A very wide field of application awaits the use of Ultra-Violet Radiation in the Maternity and Child Welfare branch of Public Health activity. Ultra-violet radiation cures rickets consistently and rapidly.
Ultra-violet radiation should be available in every infant welfare scheme in every town. Prophyllactic use of ultra-violet radiation in the first year of life would banish rickets, tetany, and spasmophilia from our infant population.

VIII. In the treatment of tuberculous disease, ultra-violet radiation exerts a marked curative effect in skin tuberculosis, bone and joint tuberculosis,

mesenteric tuberculosis and gland tuberculosis, and in the order given. In lung tuberculosis further experience is required. In the meantime, cases of pulmonary tuberculosis should be watched with particular care and minimal and very gradually increasing doses of ultra-violet radiation given.

IX. A field opening up many possibilities remains to be in the action of ultra-violet radiation in render-inert substances therapeutically and otherwise active.

X. While ultra-violet light has been known for more than a century, it is only comparatively recently that its wide application and therapeutic possibilities have begun to be explored. As in the case of the X-rays, time and patient enquiry is required before its exact scope in therapeutics can be defined.
